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RED SNOW.

BY F. C. CLARK, M.D.

Perhaps no more curious phenomenon meets the gaze of the Arctic observer than what is familiarly known as "red snow," and truly a beautiful sight must the little plant present, in direct contrast with the expanse of white, whether appearing in thinly scattered patches, or crimsoning the hills and plains for miles around.

The subject has ever been of the deepest interest, and excited the attention of the most eminent scientists. For a long time its true place in nature remained undetermined. On each side of the contest as to its affinities were arrayed most distinguished authorities, each claiming to have solved the mystery. Yet it was only after many conflicting opinions that its true position was determined. Hence if the vegetable origin of "red snow" seems conclusive enough to us, we must not forget the advantages we possess over former observers. The microscope, the natural sciences and mechanics, have all received marked improvement since the first discovery of the snow plant.

The history of the *Protococcus nivalis*, as named by Agardh, dates from a very early period in antiquity. Aristotle tells us it was known in his time. In fact it was one of the chief objects which attracted the attention of mountain travellers and of adventurers in the frozen regions of the North.

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But the most accurate accounts extant only date from 1760 of the present era. Saussure about this time made careful examinations of "red snow" obtained from the Apennines. The result of his investigations was the discovery of a vegetable substance which he supposed was the pollen of some plant.

The subject now remained quiescent until the return of the Arctic exploring expedition under Sir John Ross in 1819. New material was now obtained for examination. Specimens of "red snow" were sent to Robert Brown and Francis Bauer.

Brown gave it as his opinion that the snow plant was a unicellular plant belonging to the order of Algæ.

Bauer, however, dissented from Brown, and declared it to be a species of fungus (*Uredo nivalis*). Apart from his conclusions upon the subject, he made many interesting experiments with the plant. Its microscopical appearances and also analysis were given. But perhaps the most curious experiment was his attempts at propagating the Protococcus.

For this purpose he placed some of the "red snow" given him by Sir John Ross, and which had already become white from long exposure to the air, in a glass vessel filled with snow, taking care to mix the two well together; on exposing the vessel of snow in the open air for some time, and, fortunately, while the weather was unusually cold (in December), he found the snow to change from white to pink; and finally to regain its original color, and its quantity also to increase.

Not satisfied with this, he carried his investigations still further. He put a small quantity of the snow plant upon the surface of some snow and watched the result. The temperature being sufficiently low the same changes were observed as occurred in the former instance, but a greater increase in bulk of the plant.

From these experiments Bauer concluded that the young plant became green before it matured; that a certain degree of cold was necessary for its production, and that, if exposed to the open air alone for some days, the plant would lose its red color.[1]

In 1823 Baron Wrangel after careful analysis denied the conclusions arrived at by former observers, and pronounced the plant to belong to the lichens, naming it *Leprasia Kermesina*. So in-

[1] Philosophical Transactions, 1820, Part I. pp. 165–174.
"Microscopical observations on Red Snow, by F. Bauer. Journal of Sci. and Arts (Royal Inst. of Gr. Br.), vol. vii, 1819."

stead of clearing away all doubts he only served to introduce new matter for discussion.[2]

Two years afterwards the question was again agitated by Agardh and Dr. Greville[3] of Edinburgh. Both these observers agreed in every particular with Robert Brown. Sir William Hooker also, the eminent naturalist and botanist, later confirmed the views of Agardh and Greville; but he named the "red snow" *Palmella* instead of *Protococcus nivalis* Agardh. The algic nature of the plant was thus decided for a time.

During the year 1838 several observers on the continent, among whom may be mentioned Kunze, Unger and Martius, wrote elaborate monographs upon the subject, but without eliciting anything new.

Thus far we have had to do only with believers in the vegetable origin of the Protococcus. There are almost as many eminent observers arrayed on the opposite side, who pronounce in regard to its animal nature.

In August, 1839, Mr. Shuttleworth,[4] an English resident of Switzerland, understanding that "red snow" had been discovered in the vicinity, betook himself thither, and by the aid of his microscope was enabled to make out the presence of animalcules. Adding to these examinations he described two species of low animal organisms, and proclaimed the animal nature of the snow plant.

In 1840, Professor Agassiz of Neufchatel made a tour to the glacier of Aar, and discovering "red snow" there, carefully examined it with a microscope, and presented his views concerning the plant before the British Association at Glasgow. Not only did he fully confirm the conclusions of Shuttleworth, but he added four other species of animalcules to those already discovered and described by Shuttleworth. Agassiz considered that the opinions of former observers were due to their mistaking the *ova* of animalcules for the spores of a plant.[5]

After the confusion necessarily arising from such a variety of

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[2] Penny Encyclopedia.

[3] "Scottish Cryptogamic Flora," by Robert K. Greville. Edinb., 1825–1829. Vol. iv, p. 231.

[4] "Nouvelles observations sur la matière colorante de la neige rouge," par James Shuttleworth. Bibl. Univ. xxv, 1840. Edinb., New Phil. Journ., xxix, 1840. Froriep Notizen, xvi, 1840. Also Bibl. Univ. xxv, 1840. Edinb. New Phil. Journ. xxix, 1840.

[5] *Loc. cit.*

opinions, and each advocated by unimpeachable authorities, had somewhat subsided, the true nature of the Protococcus was at length decided. And to-day its vegetable origin is no longer doubted. It holds no middle place between the animal and the vegetable, as some have thought, nor is it even a low animal organism; but in every sense of the word an alga, as Brown, Agardh, Greville, Hooker, and many other eminent authorities have since declared.[6]

Animal substances, it is true, are found present in the alga. But this is easily accounted for when we consider the immense numbers of low animal, as well as vegetable organisms, floating in the atmosphere, and even in the most frigid of climates.[7]

Mineral substances are also present, thus misleading the chemist as well as botanist and naturalist. Hence analyses of the snow plant often strengthen the observer's private opinions, thus rendering a bias of judgment almost unavoidable.

Botanists refer the snow plant to the family *Palmellaceæ*, the lowest of plants, and related to the *Confervaceæ*. It is propagated like all the members of this family, by a kind of gemmation. A tube-like process shoots out from the plant dilating at the extremity. Gradually a cell is formed at the end of the tube, which continues contracting until the new cells lose all connection with the mother-plant, and become distinct individuals.

In some species of this family true segmentation is the rule. In this mode of reproduction the young plants exhibit for a short time remarkable powers of locomotion, which are due to the rapid vibration of an immense number of cilia. When this motion ceases, then is the signal for segmentation or reproduction to begin. When segmentation ceases, motion reëstablishes itself, then segmentation recommences, and so on.[8]

The vibration of these cilia has undoubtedly led observers, opposed to the vegetable origin of Protococcus, to regard it as similar to the zoospores of certain Protozoa. For it is a well-known fact that "red snow" possesses some degree of motion.

The Protococcus is very minute, in fact microscopical. Under the microscope it has the appearance of brilliant garnet-colored

[6] Brand's Dict., of Sci. Lit. and Art.

[7] Kane's Narrative, 1854. pp. 138–140.

[8] Chamber's Encyc. *vid.* Palmellaceæ. (See also Clark's "Mind in Nature" for original observations on American specimens by this eminent observer, illustrated by figures.—Eds.)

disks resting upon a matrix of gelatinous matter. They resemble to a remarkable degree the red globules of the blood in size and color. But Bauer gave their size as $\frac{1}{1200}$ inch in diameter; whereas more careful measurement will show the diameter of the disks to be nearer $\frac{1}{3500}$ or $\frac{1}{4000}$ inches. Each one of these globules is made up of seven or eight cells filled with a liquid, which probably contains the coloring matter of the Protococcus. But Brocklesby thinks the liquid contains great numbers of animalcules.[9]

Bauer, Wollaston, DeCandolle, Hooker, Peschier and others give chemical analyses of the snow. But as they all give nearly like results, the analysis of Peschier is only subjoined, viz.:

Silicious matter	66.50
Alumina	6.35
Peroxide of iron	21.35
Lime	1.17
Organic matter	6.80[10]

The "starch test" proves the vegetable origin of Protococcus perhaps better than any other.

The genus to which the snow plant belongs takes a variety of forms; of dust-like particles, as in the case of "red snow;" of a stringy gelatinous mass as in "gory dew;" or of a thin and membranous structure, like a frond.

Dr. Kane found the color to be of a dark red. On paper it produced a cherry red stain, which became brown on exposure to the air. Its solution in water, in which red snow is very soluble, is of a muddy claret color. But if the snow were damp, upon which it was found, the snow beneath was stained a beautiful pink.[11]

The Protococcus is found above 83° north latitude, and as far south as in New Shetland in 70° S. Lat. Sir John Ross saw it extend over the cliffs bordering upon Baffin's Bay for a distance of eight miles, and, in some instances, to a depth of twelve feet. To this day the heights are called the "Crimson Cliffs."[12]

Parry found "red snow" even far from land upon the ice-fields of Spitzbergen. Kane obtained it fifty miles from land upon the floes of ice. Here it seems to have been diffused through the

[9] Brocklesby's Meteorology, pp. 120–121.
[10] Penny Encyclopedia.
[11] Kane's Narrative, 1851, 1854. pp. 138–140.
[12] Kane's Narrative.

atmosphere over the Arctic snows like other organic matter. Kane also found it mixed with foreign vegetable matters, which might perhaps be the source of the ammonia necessary for its existence. Indeed the snow plant was always of a deeper red, and in a more flourishing condition in proportion to the quantity of this extraneous matter.[13]

This alga is found also upon the tops of high mountains above the snow-line. It has long been known to exist in the Apennines and Pyrenees Mountains. The recent discovery of the snow plant in our own country (in California) upon the tops of the Sierra Nevadas, at an altitude of 10,000 feet above the level of the sea,[14] renders the subject under discussion of twofold interest. Specimens obtained from this locality show the same structure and microscopical appearances as those from other parts of the world.

Damp places, near the ocean or fresh water, seem to favor its production. The specimens supplied to Dr. Greville were from the shores of Lismore, off Scotland. It was found upon reeds and stones, but grew to perfection upon calcareous rocks.[15]

A species of alga (*Uredo viridis*) of a greenish color has been described. But Martius refers it to the *Protococcus nivalis*, though in a different stage of development.

Other varieties of colored snow have been mentioned, which are confounded with Protococcus. What is known as "brown snow" is due to a discoloration of the snow by earthy matters washed down by mountain streams. Arctic observers (Belcher) speak of a red snow produced by a species of little auk which feeds on shrimp and congregate there in immense numbers.

Snow and ice often appear colored from reflection. These illusory appearances are easily explained. Dr. Kane speaks of "red ice" which, on a nearer inspection, proved to owe its red color to reflection. The same observer mentions "blue ice" as being sometimes seen, and due to like causes.[16]

But apart from all this, the Protococcus declares its vegetable

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[13] Kane's Narrative.

[14] It was also discovered at an elevation of 6,500 feet on the Cascade Range in Washington Territory by the late George Gibbs. See NATURALIST, v, p. 116, 1871. — EDS.

Red snow is not seldom found among the Sierras, in the so-called Alpine regions; in Clover Mountains, East Humboldt, Nevada and the Uintahs, from July to September. It is found upon old snow drifts (vid. U. S. Geol. Explor. of 40th parallel, vol. v, Botany, 1871. Page 415, Prof. H. C. Woods).

[15] Penny Encyclopedia.

[16] Kane's Narrative, pp. 138–140.

origin. And yet, why it should prefer to make the snow its habitat, or how it can find its way into those regions of frost and infertility, remains a question which still perplexes the naturalist and philosopher.

THE SISCO OF LAKE TIPPECANOE.

BY PROF. D. S. JORDAN.

A short time since, I received from Prof. E. T. Cox, state geologist of Indiana, a collection of deep-water "Siscoes" taken in Lake Tippecanoe, Kosciusko Co., Indiana, by Judge J. H. Carpenter of Warsaw. Prof. Cox requested me to examine these fishes, and prepare an account of their characters and relationship, as considerable interest is attached to them as well as to the fauna in general of the "bottomless lakes" of northern Indiana.

I find them to be Salmonoids belonging to the genus Argyrosomus of Agassiz, a group closely allied to the white fishes (Coregonus) but distinguished by the greater development of the lower jaw, which usually projects decidedly beyond the upper, the reverse being true of Coregonus. The maxillary bones are rather longer, and the bones of the mandible rather heavier, and the teeth although very feeble are slightly stronger than in Coregonus. Compared with Coregonus most of the species have a more slender form; hence their popular name of "lake herrings," although their resemblance to the sea herring is quite superficial.

This Indiana Argyrosomus appears to be quite distinct from the species found in Lake Michigan; *i. e.*, the shallow-water "herring" (*A. clupeiformis* Mitch.) and the deep-water "moon eye" (*A. Hoyi* Gill) and "black fin" (*A. nigripennis* Gill), and it is presumably different from *A. harengus* (Rich.) and *A. lucidus* (Rich.), which, if really distinct species, seem to be loose-scaled, shallow-water fishes, allied to *A. clupeiformis*.

It seems to be identical with the "Sisco" of the deep lakes of southern Wisconsin, a fish, which, although known for some time to naturalists, has not yet, as far as I am able to ascertain, received any specific name.

I have therefore ventured to describe these fishes as new, under

the name *Argyrosomus Sisco*,[1] taking as the type of the species several specimens — male and female — from Lake Tippecanoe, caught in the spawning season, about Nov. 25, 1874. Comparisons with *A. Hoyi* and other related species are made below. I am indebted to Dr. Hoy for specimens of *A. Hoyi* and the Wisconsin "Sisco," and for the opinion that the latter is entirely distinct from *A. nigripennis*, a species which I have been unable to obtain.

This fish has been found in Geneva Lake in Walworth Co., Lake Mendota in Dane Co., and, I think, in Lake Koshkonong. It should be noticed that these lakes belong to different water systems, Geneva Lake being drained by Fox River, a tributary of the Illinois, Lake Mendota by Cat-fish River, a branch of Rock

[1] ARGYROSOMUS SISCO Jordan.—Form regular, spindle-shaped, compressed, slightly elevated at the beginning of the dorsal fin; general outline not very different from others in the genus.

The greatest depth of the body is contained 4 1-10 times (4 1-4 in males, 4 1-2 in *A. Hoyi)*, in length from tip of snout to the end of the scales at base of caudal. The thickness of the body is about half its depth. The head is moderate, pointed, compressed and depressed. The skull is flattish above, with a longitudinal ridge. The interorbital space is slightly wider than the eye. The length of the head is less than the height of the body (nearly equal in males), and is contained 4 1-2 times (4 1-3 to 5; 4 in *A. Hoyi*) in length of body exclusive of caudal. The eyes are large and circular, and their diameter is contained 3 3-5 (3 1-2 to 3 3-4; 3 1-2 in *A. Hoyi)* times in the length of the side of the head. The nostrils are large, nearly midway between eye and tip of snout, and on the upper surface of the head.

The opening of the mouth is rather small and quadrangular. The lower jaw is longer than the upper, rather less so than in *A. clupeiformis*, very much more so than in *A. Hoyi*, which is almost Coregonus-like in this respect. A slight elevation at the tip of the lower jaw, suggesting the "nail" on the bill of ducks, overlaps and fits into a slight emargination at the end of the upper jaw. Margins of lower jaw with slight roughnesses representing teeth. Intermaxillaries with minute asperities. Tongue provided with minute teeth which however are readily evident.

Maxillaries rather strong, weaker than in *A. Hoyi*, contained 3 1-3 (2 3-4 in *A. Hoyi)* times in side of head, not reaching a vertical line through the centre of the eye.

Length of mandible much more than least depth of tail. 2 1-8 (2 in *A. Hoyi)* times in head. General characters of opercular bones, branchial openings and branchiostegals as in other species.

Distance from occiput to tip of snout contained 2 1-3 times (1 7-8 in *A. Hoyi)* in distance from occiput to beginning of dorsal. Depth of head at occiput 2-3 the length of the side of head.

The scales are relatively smaller than in most of the other species, the lateral line having 84 developed scales (81 to 86; 75 in *A. Hoyi*, 73 in a specimen of *A. clupeiformis)* besides several small ones at the base of the caudal, which form a concave margin somewhat parallel with the fork of the fin, as in other species.

The scales, though thin, are quite firm, rather less so than in *A. Hoyi*, very much more so than in the "Lake Herring."

The lateral line is very evident, nearly straight, and rather nearer the back than belly. There are eight series of scales between the lateral line and the ventrals.

The radial formula is D. II, 9 or 10, P. 15, V. 12, A. I. 12.

The dorsal fin begins in front of the ventrals at a point about equidistant between the front margin of the eye and the first rays of caudal. It is short and rather high;

River, while Lake Tippecanoe is one of the sources of Tippecanoe River, which flows into the Wabash. I have not heard of these fishes in Lake Winnebago or any water flowing into Lake Michigan. In Lakes Winnebago and Buttes des Morts the name "Sisco" has been transferred to the common white lake bass (*Roccus chrysops* Gill).

Concerning the habits of the Indiana Sisco, we have the following information from Judge Carpenter:

"Some years ago, probably five, these fish were discovered on the north side of Tippecanoe Lake by Isaac Johnson, and at each return of their spawning season, which is in the last of November, they have reappeared in large numbers. They are not seen at any other season of the year, keeping themselves in the deep water

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its greatest height is a little more than 2-3 the length of the head. Its length is 2-3 of its greatest height. Its longest ray is a little more than 3 times the length of the shortest, thus giving the fish a different form from *A. Hoyi*, in which the longest ray of the dorsal is nearly 4 times the length of the shortest. The adipose fin is rather slender and reaches slightly beyond the termination of the anal.

The pectorals are rather long and pointed, about as long as the ventrals and of course not reaching nearly to them.

The ventrals are rather large, more than 2-3 the length of the head, falling considerably short of vent. The accessory scale at their base is rather short and triangular, less than half the length of the fin. The depth of the body at the vent is contained 5 3-4 (6 3-4 in *A. Hoyi*) times in the length of the body.

The caudal fin is deeply forked, its lobes are long and pointed, but in all my specimens more or less mutilated. The distance from the vent to the rudimentary caudal rays is contained 4 3-5 (4 1-2 in *A. Hoyi*) in the length of the fish.

The color (from fresh specimens), deep steel-blue above becoming gradually paler to below the lateral line, where it changes to silvery. The arrangement of the scales gives an appearance of longitudinal lines which are conspicuous in certain lights.

All the scales except those of the belly are finely dotted with black, except on their free margins, which being transparent, show the dots on the scales below.

Vertical fins and tips of paired fins also thickly punctate, as well as the skin of the head, particularly above and on the maxillaries and suborbitals.

These black dots seem to be of specific importance as they occur in both Wisconsin and Indiana specimens. They are not noticeable on *A. Hoyi*, excepting on the head. The latter is a more brilliantly colored fish, its scales having a peculiar rich silvery lustre wanting in the Sisco.

Average length of specimens examined, 9 1-2 inches, including the caudal fin, being thus larger than *A. Hoyi*, which rarely exceeds 7. The largest specimen of the Sisco seen measures 10 1-2 inches. Larger individuals sometimes occur. Mr. Carpenter writes that "occasionally one is caught weighing 1 1-2 to 2 pounds, but it is very unusual to find them so large."

The single specimen in my possession of the Wisconsin Sisco agrees in the main with the above, but it is a slimmer fish (perhaps owing to sex or season), the depth being contained 5 times in the length of the body, the head 4 2-3 and the eye 4 times in the head. The maxillary is longer, 2 7-8 in length of head, the depth at the vent 6 3-4 in the length of the body, and the distance from vent to base of caudal only 4 times. The scales are obviously larger, there being but 77 in the course of the lateral line. To how much weight these differences are entitled can only be told by a comparison of a number of specimens.

of the lakes. The general opinion is that they will not bite at a hook, but Mr. Johnson says that he has on one or two occasions caught them with a hook. To my knowledge they have never been found in but two of our lakes, Tippecanoe and Barber's, which are both large lakes and close together, as will be seen by reference to the map.

The spawning season lasts about two weeks and they come in myriads into the streams which enter the lakes. There are large numbers of persons who are engaged night and day taking them with small dip nets. They are caught in quantities that would surprise you, could you witness it. Those who live in the neighborhood put up large quantities of them, they being the only fish caught in the lakes that will bear salting. Some gentlemen who have been fishing to-day (Dec. 8) inform me that the run is abating and that in a few days the fishes will have taken their departure for the deep water of the lakes, and will be seen no more until next November."

As far as I can learn, the habits of the Wisconsin Sisco are similar, but they seem to be much less abundant. Fishermen say that specimens were once sent to Prof. Agassiz, who pronounced them something "new and extremely rare." Specimens procured for me last year, by Prof. Copeland, cost a dollar apiece of the fisherman, which shows the high value attached to these fishes, as *A. clupeiformis* when taken from the nets is not worth more than ten cents a dozen.

Concerning the Lake Michigan species Dr. Hoy writes me, "*A. nigripennis* is a large, magnificent fish. It can be known at once by the black fins. It is never caught in less than 60 fathoms, and not in large numbers till you reach a depth of 70 fathoms. The *A. Hoyi* is the smallest of the Salmonidæ, if I am not mistaken. It never approaches the shoal water, where *A. Artedi* (= *A. clupeiformis*) is only found. About 30 or 40 fathoms is as near shore as it has ever been captured here."

BOTANICAL OBSERVATIONS IN SOUTHERN UTAH. II.

BY DR. C. C. PARRY.

On the 8th of May an opportunity offered of making an excursion in a southwestern direction to the Beaver-dam Mountains, about twenty miles from St. George. This range forms a high dividing ridge extending in a southeast course, separating the valleys of the Santa Clara and Muddy Rivers, which are the principal northeastern tributaries to the Rio Virgen. Through this mountain mass, composed of variously inclined sedimentary rocks made up of alternate strata of sandstone, limestone, and variegated marls, with immense beds of gypsum, the main stream of the Virgen cleaves its way by an impassable cañon. Our route after crossing the Santa Clara near its mouth, then flooded with melted snow and turbid from the dissolved mud of its lower alluvial banks, followed up one of the "dry washes," as they are significantly termed, leading more directly towards the mountain slope. Along the course of this sandy bed, the "desert flowering willow" (*Chilopsis linearis*) was abundant, though not yet fully leaved out, nor offering any display of its showy Catalpa-like blossoms. Still more conspicuous at this season of the year was the *Cowania Mexicana*, then completely covered with a profusion of pure white flowers, almost hiding from view its finely divided varnished leaves. A pleasant balsamic fragrance, exhaled in the clear atmosphere from this charming shrub, lent additional attractions which seemed to be appreciated by a swarm of hovering insects. The adjoining uplands were composed of various colored clay and sandy knolls, often fantastically washed, and intersected by miniature ravines and deep basins. The vegetation on these slopes was mainly composed of the prevalent Chenopodiaceæ, occasionally set off by the more graceful forms of Larrea, Algarobia, or the showy *Dalea Johnsoni*. Amid the more usual forms of undergrowth, made familiar in my rambles near St. George, my attention was drawn at a single locality to a showy Papaveraceous plant, with nodding white flowers, in which I was delighted to recognize the *Arctomecon Californicum* Torr. (No. 6), collected only by Fremont thirty years ago, and figured and described in his report from a

single specimen. The present collection, since supplemented by mature fruiting specimens, furnishes the means of completing the description of this interesting plant, which seems to differ from the original figure in its less hairy leaves, four (not six) valved capsule and more cæspitose habit. The fruiting specimens show marcescent petals, persisting after the maturity of the seed, and an eversion of the upper third of the triangular valves, leaving the placental ribs connected at the summit with the united stigmas and forming a basket in which the shining black seeds lie loosely like so many eggs. The plant is apparently biennial, with deep tap roots, the broken stem and leaves giving out a yellowish sap. In the two localities where found it grew in a loose marly soil, strongly impregnated with gypsum.

On reaching a higher elevation on a continuous upward grade there was brought to view a greater profusion of plants and shrubbery, conspicuous among which may be noted *Audibertia incana*, *Coleogyne ramosissima*, and a cæspitose yellow-flowered Mamillaria (*M. chlorantha* Engel., ined.). At our nooning place, having reached an elevation of not less than one thousand feet above the valley of the Virgen, a deep gorge in the limestone rocks afforded a scant supply of water. In the abrupt face of these perpendicular rocks, a delicate fern was noticed, which Prof. Eaton has determined to be identical with the *Notholæna tenera* Gillies, from the South American Andes, not before found in North America. Owing to the shortness of our stay and the difficulty of securing specimens from the inaccessible positions in which they grew, only scanty collections were made, but the locality is so readily identified that some future botanist will be able to supply the demand for this interesting addition to North American Filices. Other plants afforded by this locality were the diminutive *Œnothera pterosperma* Watson (No. 70), *Astragalus arrectus* (No. 45), a tall Phacelia of a climbing habit with foliage resembling *P. tanacetifolia*, but apparently distinct, *Phacelia ramosissima* Benth. (No. 184) and a robust showy form of *Eriogonum ovalifolium* Nutt. (No. 241).

Farther on in our upward ascent, we reach a growth of clumpy cedars, being the common species of this country, extending from Lake Utah to Arizona. This is the *Juniperus tetragona*, var. *osteosperma* Torr., since determined by Dr. Engelmann to be a variety (*Utahensis* ined.) of the western species, *Juniperus Californica*.

It is readily distinguished from the more common *Juniperus occidentalis* Hook., with which it is probably associated farther south, by its larger green mealy-coated fruit, one-seeded, with a hard stony shell, the mature fruit fading chocolate-brown, not purple, etc. With this tree at all high elevations the common "Piñon" (*Pinus edulis* Engel.) is quite constantly associated. The undergrowth here exhibits less of a desert feature in the presence of such plants as *Streptanthus cordatus* Nutt. (No. 10), *Pentstemon puniceus*, var. (No. 152), *Phlox canescens* Torr. & Gray (No. 186), *Eritrichium leucophæum* DC. (No. 166). Quite a conspicuous feature in the floral landscape was presented by dense clumps of *Berberis Fremontii* Torr. (No. 5), then in full flower, its bright yellow racemes contrasting prettily with its stiff spiny holly-like leaves.

Near the close of the day in ascending the last sloping ridge, leading down on the opposite side to the wide desert plain through which the Muddy courses to unite with the Virgen, we first recognized one of the principal objects of our journey in the singular forms of that remarkable desert production, *Yucca brevifolia* Engel. This is universally known among the Mormon settlers under the name of "*The Joshua*." The mail rider over these desert tracts had furnished us weekly reports of its progress in flowering, so that we were constantly on the lookout for a first view of what had never yet been examined by a scientific botanist. At first a few scattering clumps of the peculiar stiff spiny leaves that characterize this genus of plants attracted attention, then some gaunt forms raised on withered trunks revealed the identical species. On hastening forward to a more vigorous growth, where the masses of compact flowers were visible at a distance crowning the top of the upper branches or main axis, we soon had one of the lower flowering stems ruthlessly torn down for a closer inspection. The first feeling was one of disappointment; the flowers, crowded in a close pyramidal head, failed to exhibit the ordinary graceful forms pertaining to the Liliaceæ. The perianth was of a dull greenish-white color, its divisions long-linear, thickened and confusedly massed together, while the odor given out was decidedly fœtid, seeming to present special attractions only to various beetles and insect larvæ. An examination of the inflorescence shows a regularity such as the botanist would expect: the upper leaves of the flowering branch gradually becoming bract-form subtend in their axils small jointed flower-stems, with the lower flowers generally

arranged in threes. These in continuing their spiral arrangement on the main axis form the condensed mass of flowers which, opening from below upwards, prolong the flowering process for several weeks. Only a few of the flowering stems perfect fruit, and occasionally (as during the present season) all prove abortive, possibly owing to the absence of some insect agency for effecting fertilization. In the desert districts lower down, where this species especially flourishes, the flowering heads are said to weigh frequently over fifty pounds.

The material and notes now supplied will, it is hoped, enable Dr. Engelmann who has made a special study of this genus, to complete the technical description of this remarkable species.

A short ramble on the following morning in the vicinity of our camp brought to view some other points of botanical interest. Quite common on loose gravelly slopes occurred the neat species of Ranunculus, *R. Andersonii*, Gray (No. 2). This differs from the figure and description in Watson's Bot. King's Exp., in its constant branching habit, rendering this variety better suited for horticultural purposes. Its marcescent petals seem to retain to some extent their bright color and streaks after the maturity of the achenia.

Here also were found the singular Rutaceous shrub, *Glossopetalon spinescens* Gray (No. 27), and *Spiræa Millefolium* Torr., which closely simulates *Chamæbatia foliolosa* Benth. Along the edges of dry ravines *Astragalus eriocarpus* Watson (No. 44) was quite frequent, usually associated with *Eritrichium leucophæum* DC. (No. 166) and the handsome *Pentstemon puniceus* Gray (No. 152). On the summit of a high limestone ridge overlooking the valley of the Muddy, was seen for the first time the dwarf species of Agave, *A. Utahensis* Engel. This species, which adheres quite closely to crevices in the limestone rocks, forms extensive patches by sending out offsets, so that in cultivation it could be readily propagated, making an interesting addition to the class of hardy pot plants. At the time of our visit it was just sending up its flowering stalks, too early, however, for securing herbarium specimens, which had been supplied in the collections of Dr. Palmer four years previous, from which the original description was drawn.

The hasty return trip to St. George, loaded down with Yuccas, Cacti, and Agaves, did not afford much opportunity for excursive botanizing.

With the advent of prolonged summer heat the Eriogoneæ became especially prevalent both in variety of species and number of individual forms. Thus with the exception of Nemacaulis and Lastarriæa (the latter probably lately introduced into California from Chili), we have representatives of all the North American genera of the tribe. Of these, Eriogonum includes eleven species, Chorizanthe two, Oxytheca, Centrostegia and Pterostegia, one each. Of the slender annual species of Eriogonum some are remarkably gregarious in their mode of growth, forming dense patches that give a singular aspect to the bare landscape. This is particularly marked in *E. reniforme* Torr. (No. 237) and *E. trichopodum* Torr. (No. 240). More irregularly scattered over rocky slopes occurs the singular fistulous-stemmed species *Eriogonum inflatum* Torr. (No. 230); this from the peculiar bulging appearance of its main stalk and upper branches, sometimes fully one inch in diameter, has received the fanciful popular name of "bottle stoppers." Early in the season the young and tender shoots afford an agreeable sub-acid juice not unwelcome to the thirsty traveller over these arid tracts, in lack of more attractive cheer suggested by the above popular name. Later in the season *E. Parryi* Gray, n. sp. (No. 239), with its broad cordate leaves and divaricately branching flower stem, is commonly met with on rocky slopes, being usually associated with *Chorizanthe brevicornu* Torr. (No. 230) and *Chorizanthe rigida* Torr. (No. 231). On dry sandstone rocks, *Eriogonum racemosum* Nutt. (No. 234) is conspicuous, and in favorable localities there is an abundance of the singular *Oxytheca perfoliata* Torr. & Gray (No. 228) and *Centrostegia Thurberi* Gray (No 232).

Not infrequent in the shade of overhanging rocks adjoining the Virgen is a very neat species of Symphoricarpus recently described by Professor Gray under the name of *S. longiflorus* (No. 87). This shrub forming dense clumpy masses, with slender branches, small foliage, and delicate white flowers streaked with pink, would make an interesting addition to this class of common cultivated shrubs; unfortunately the flowering season was too late to secure mature fruit to determine its scientific characters or make it available for garden cultivation. Quite constantly associated with the above is a slender-leaved suffruticose Arenaria, *A. Fendleri*, var. *glabrescens* Watson (No. 20), which from its peculiar habit and mode of growth it is difficult to regard as a mere variety of that widely spread subalpine species.

Among the rarities of this section must be noted a well marked new species of the peculiar southwestern genus Petalonyx, characterized by Prof. Gray as *P. Parryi* n. sp. (No. 75), this making a second recent addition to the genus. Of this only a single plant was met with, forming a low bush with remains of dead stalks, especially conspicuous at a distance from the faded leaves of the previous season's growth, exhibiting a pure pearly white. The delicate cream-colored blossoms, with exserted style and stamens, reminded one of Lonicera, but the polypetalous flowers and the peculiar hairy brittle leaves designated it at once as belonging to the Loasaceæ. A diligent search over the dry gravelly and alkaline soil, where it was found associated with the common "grease woods" of this region, failed to bring to light any other plants, so that this single locality, precariously situated within a stone's throw of the great Mormon temple, does not encourage the hope of a prolonged existence for the benefit of future botanists.

Another interesting plant of this same family was also met with in crevices of denuded sandstone rocks near the Santa Clara. This I recognized at once as an old acquaintance, having several years previously collected imperfect specimens of the same, past flowering, on the Lower Colorado. Of this, provisionally named in a manuscript list *Eucnide urens* Parry, full material has now been collected, from which Prof. Gray has recently published a description in the Proceedings of the American Academy, Vol. x, pp. 71–72, under the name *Mentzelia* (*Eucnide*) *urens*, n. sp. (No. 79).

Another plant especially worthy of notice belongs to the natural order *Asclepiadaceæ*. It is a small twining milk-weed, growing in loose drifting sand, in which the thick tap roots are deeply buried; these send up several slender stems, which cling to the scanty shrubbery or lie prostrate on the scorching sand, where blown about by the wind they form irregular and constantly changing circles. The small umbels of flowers in the axils of the upper leaves are of a dull yellow color and are without the usual horny appendages. Dr. Engelmann, to whom specimens have been sent, has characterized it in the accompanying list under the name of *Astephanus Utahensis*, n. sp. (No. 209).

A frequent associate of this latter plant is the little known *Dicoria canescens* Gray, an annual composite plant allied to Franseria. In similar dry sandy soil was also found *Franseria eriocentra* Gray, forming an irregularly branched bushy shrub two to three feet in height.

With the disappearance of the ordinary class of desert annuals, the early summer rains bring forward a peculiar set of composite plants, remarkable for their strong odor, due to a large development of oil-bearing glands. These include two species of Psathyrotes, viz., *P. annua* Gray (No. 114) and *P. ramosissima* Gray (No. 115). Besides these is a plant not seen by me, probably a Pectis, which spreads over the ground in prostrate mats, its foliage so strongly charged with an aromatic oil that it is extracted by a rough process of distilling for domestic use, the plant receiving the popular name of "head-ache weed." Later in the season my attention was mainly taken up in the collection of seeds. This though generally tedious and uninteresting, especially when requiring exposure to the hot mid-day sun, yet offered not a few points of peculiar attraction. It was instructive in passing over these arid tracts to note the provision made for scattering or preserving these necessary products for the succeeding season's growth. Thus the evanescent annuals drop their seeds in the loose sandy or gravelly soil or rock crevices, in the most suitable conditions for retaining their vitality during the hot dry season, while the withered stems, having fulfilled their part in the processes of growth and reproduction, dry up and are blown away. Deep sun-cracks in the strongly impregnated gypseous soil receive the seed of the future crop of annual Œnotheras, Gilias, Phacelias and Eriogonums, to be covered up by the first rains. The species of Compositæ, not so generally here as elsewhere provided with a feathery pappus for transporting their seeds, maintain their foothold by unusual productiveness. Even in the case of *Glyptopleura setulosa* Gray, which seems amply furnished with a light capillary pappus, it is rare to find the aigrette expanded, and the matured achenia remain enclosed in the involucre, thus leaving them to be planted in the loose soil with the dried-up remains of the parent stem. Another instructive example is presented by *Tetradymia spinosa* H. & A., in which the seeds are wholly covered with a white woolly down, and at the season of maturity are thickly scattered over the arid tracts in which it grows, gathered by the wind like snow drifts, into every sheltered nook, or clinging to the adhesive hairs of branching Mentzelias.

Bulbous plants, such as Androstephium and Calochortus, hide their newly formed bulbs in the gravelly soil at depths practically inaccessible to all but curious botanists or hungry Indians. A

singular arrangement for shooting seeds was brought to my attention in the case of *Gilia setosissima* Gray. Wishing to collect somewhat largely of the seeds of this neat little annual, I watched more closely than usual the maturity of the capsules. In most of the other species of this prevalent genus, there is a succession of flowers and maturing capsules, which latter opening at the summit discharge their seeds while the plant is still producing flowers, thus rendering it difficult to secure a large quantity of seed without including capsules not sufficiently mature. But in the case of *Gilia setosissima*, all the capsules remain tightly closed till the whole plant becomes dry and brittle. In then gathering seed by picking each plant separately, I noticed the seed projected with some force against my hand. On closer examination I found that these capsules open from below upwards, and that the tension accumulated by the shrinking of the tissues in the process of drying gives an elastic spring to the three separating valves when released from their attachment at the base of the calyx, that throws the contained seed from two to six feet. After making this discovery it was interesting to watch the process by loosening the attachment of the valves with the point of a knife, and see how far they would shoot. The majority of the seeds were scattered within a radius of two feet, while in the plumper capsules the shots took effect to a distance of six feet or more. The three separated valves of the capsules on account of their light chaffy texture were not thrown as far as the seeds.

A similar character, though less marked, was also exhibited in certain species of cæspitose Phlox, though in this latter case the explosions observed occurred some time after the capsules were detached from the calyx. The conclusion arrived at is that the character of explosive capsules in this particular family is peculiar to those that open at the base instead of the summit.

In the succeeding paper I shall conclude this account of botanical observations in Southern Utah by a notice of a short excursion to the alpine district of Pine Mountain, and a more prolonged stay in the vicinity of Cedar City, including a visit to the elevated sheep pasture in the adjoining mountain range,—to be followed by an appendix containing a full list of the plants collected, with descriptions of the new or imperfectly known species.

THE PRAIRIE GOPHER.

BY DR. ELLIOTT COUES, U.S.A.

THE subject of the present history is one of a large group of small quadrupeds inhabiting the western half of North America, from Mexico to the Arctic Ocean, as well as a large portion of the northern hemisphere in the Old World. They belong to the family of the squirrels (*Sciuridæ*); in fact, they are squirrels modified in a particular way for a terrestrial instead of arboreal mode of life. We are all familiar with the common little chipmunk of the eastern states, *Tamias striatus*, and know that, on comparison with a true tree squirrel, it differs in having a shorter and less bushy tail, in possessing large cheek pouches, etc. Now *Tamias* is just one step away from *Sciurus* towards the genus *Spermophilus;* and this genus is the group to which the prairie gopher belongs. In fact *Tamias* and *Spermophilus* very nearly run together, so gradual is the transition among the several species. If we were to take a chipmunk and crop its ears down close, cut off about a third of its tail, give it a blunter muzzle, and make a little alteration in its fore-feet, so that it could dig better, we should have a pretty good spermophile, to all intents and purposes. A little further change in the same points would make a prairie dog, which is a kind of spermophile, though now placed in a different genus (*Cynomys*). An extreme of modification, still in the same direction, gives us the squat, heavy woodchucks, *Arctomys*, between which and the lithe graceful tree squirrels we see that the chain of beings is unbroken. We see now just the links which the spermophiles furnish. They are terrestrial, fossorial, gregarious squirrels — by which I mean that they live sociably in burrows under ground. The broad prairie is their home. Though one or two species are found in wooded places, yet they rarely, if ever, climb trees, and are only at home in perfectly open ground. This fact alone determines their geographical distribution. Only two species are found at all east of the Mississippi, and these too haunt the prairie. But they occur in profusion from the plains to the Pacific, from Mexico northward.

Now that we have some idea of the animals, the next thing is

to find a name for them. "Ground squirrel" would be unobjectionable and indeed appropriate, but that is already in use for the species of *Tamias*. "Marmot" is sometimes used, the present species being the tawny marmot of some writers, but this is the name of the woodchucks (*Arctomys*). "Spermophiles" they have been called; but this word is so thoroughly un-English that it will probably stay in the learned books where it arose. Naturalists, in fact, have no English name for these animals. But by the people who live among them they are universally called "gophers;" and as this name will certainly stick in the vernacular for all time, we may as well accept it. We will say "gopher," then.

I elect to write about the prairie gopher — as I shall call that particular species known in the books as *Spermophilus Richardsoni* — for several reasons. In the first place, I know more about it than I do about any other species of the genus at present. Secondly, nobody else seems to know much about it. Thirdly, it is one of the most abundant animals of our country, occurring by hundreds of thousands over as many square miles of territory, almost to the exclusion of other forms of mammalian life. Millions of acres of ground are honeycombed with its burrows. Throughout a vast stretch of country in the northwest, gopher-holes and buffalo-chips are the most noticeable points about the landscape. How far from being exhausted is the natural history of the United States, when of such an animal as this next to nothing to the point is found written down about it, beyond a description of its skin and skull and a sketch of those characteristics which it shares with other *Spermophili!* Until recently, indeed, a stuffed skin of the prairie gopher was something of a rarity. Let me make such statements good: the latest authority on North American mammals says no specimens of this species were collected by any of the Pacific railroad expeditions, and makes use of one in the Philadelphia Academy for description, collected in the Rocky Mountains by Townsend more than thirty years ago. Prof. Baird is further at pains to record the fact that in 1855 Dr. Hayden met with a small spermophile, probably of this species, in considerable numbers, north of Fort Union, but was unable to procure specimens; and goes back to Sir John Richardson (1829) for some further items of geographical distribution. Audubon's biography is almost entirely from Townsend, who evidently knew the animal well, and is very good, as far as it goes.

During a considerable portion of two years, my lines have been cast in the very home of these animals; at any rate, I fancy they cannot be more abundant anywhere else. I have crossed the continent by another route, much farther to the southward, but I never saw any animals—not even buffalo—in such profusion. I have ridden for days and weeks where they were continuously as numerous as prairie dogs are in their populous villages. Their numbers to the square mile are vastly greater than I ever ascertained those of *S. Beecheyi*, the pest of California, to be, under the most favorable conditions. In a word, their name is legion. If Dakota and Montana were the garden of the world (which they are not, however), either the gophers or the gardeners would have to quit.

Should certain portions of the Territories just mentioned ever come to be settled, the little gophers will contend with the husbandmen for the land more persistently and successfully than the Indians can hope to. Already, though the population of the gopher districts has consisted principally of Indians and certain British-American surveying parties, these insignificant quadrupeds have killed men and horses. Their holes are small, but many of them, like the burrows of the badgers, foxes and prairie wolves, will admit a horse's hoof. The risks run in buffalo hunting on horseback spring chiefly from this source; what little the huge beasts themselves can accomplish in self-defence is utterly insignificant in comparison with this ever present danger. In some regions it is impossible to gallop a hundred yards except at risk of life or limb.

My observations on the prairie gopher have been confined to a narrow belt of ground along the parallel of 49°. Exactly how far they range on either hand I am unable to say — probably farther north than south. Perhaps the upper Missouri may nearly limit their dispersion southward. Speaking generally, they extend from the Red River of the North to the Rocky Mountains. Baird speaks of their occurrence in Michigan; but I never saw any in Minnesota, nor indeed in the immediate valley of the Red River, even on the Dakota side. There the genus is represented by *Spermophilus Franklini* and *S. tridecemlineatus*. But they appear in abundance just as soon as, in passing westward, we cross the low range of the Pembina Mountains, and strike perfect prairie, characterized by the presence of such birds as Sprague's lark and

Baird's and the chestnut-collared bunting. From this point they stretch clear away to the Rocky Mountains, subsiding only among the foot-hills of the main range, where the pocket gophers (species of *Thomomys*) begin to claim the soil; but a day's march, indeed, from the rocky haunts of the little chief hare (*Lagomys princeps*). The region of the Milk River and its northern tributaries, most of which, as well as the river itself, cross 49°, is their centre of abundance. Approaching this parallel from another direction, namely up the Missouri and across country northwesterly from Fort Buford,[1] I first met with them near the mouth of Milk River, and they almost immediately became abundant. They doubtless extend down the Missouri to the mouth of the Yellowstone beyond. Audubon gives the latitudinal distribution from 38° to 55°. The recently described *S. elegans* and *S. armatus* of Kennicott (Proc. Phila. Acad. 1863, 158), both being mere varieties of *Richardsoni*, carry the range of the species in the Rocky Mountain region down to the vicinity of Fort Bridger.

As already said, the gophers overrun all this prairie country. Travelling among them, how often have I tried to determine in my mind what particular kind of ground, or what special sites, they preferred, only to have any vague opinion I might form upset, perhaps in a few hours' more riding, by finding the animals as plentiful as ever in some other sort of a place. Passing over a sterile, cactus-ridden, alkali-laden waste, there would be so many that I would say "this suits them best;" in camp that very night, in some low grassy spot near water, there they would be, plentiful as ever. One thing is certain, however; their gregarious instinct is rarely in abeyance. A few thousand will occupy a tract as thickly as the prairie dogs do, and then none but stragglers may be seen for a whole day's journey. Their choice of camping grounds is however wholly fortuitous, for all that we can discover, and moreover the larger colonies usually inosculate.

What a country it is, to be sure, where the most persistent of the minor inequalities of surface are little heaps of dirt alongside of little holes! But about these holes, which I suppose I ought to describe, there is nothing remarkable whatever, except their numbers. They are all pretty much alike, yet no two are exactly the

[1] Fort Union, formerly a somewhat noted locality, now a mere heap of rubbish, stood about on the line between Montana and Dakota. Fort Buford, a flourishing post about two miles from the old site, now commands the mouth of the Yellowstone.

same. If we fancy an active, industrious, muscular little animal to begin to scratch with strong sharp claws, and to keep at work throwing out the dirt behind him till he has buried himself in a crooked passage that will just comfortably let him pass into the ground several feet below the surface, we have a good idea of the burrow. There is not the slight rule observed as to direction and distance, any more than there is as to location. An average sized burrow will just not admit a man's arm, except at the mouth, where it is usually funnel-shaped. It may go straight down, but generally slants very obliquely, and most frequently there is an elbow a foot or so from the surface. I do not think that the holes are anything like as deep as those of prairie dogs. I never dug one out, indeed, but I judge by the peck or bushel of earth usually thrown out, as well as by the fact that it is very easy to drown out the animals with two or three bucketfuls of water. Moreover, I am satisfied that the burrows do not, as a rule, intercommunicate — perhaps they never do, except by accident, when many animals are living side by side. Many holes are found with no earth at the entrance — a clean, circular opening in the grass. These are obviously points where the creatures have burrowed up to the surface again from below. If the animals have any preference, it is a choice of the lighter and more easily worked soils, rather than a question of location. They seem to haunt especially the slight knolls of the prairie a few feet above the general level. There the soil is looser, and the inhabitants have some little additional advantage in their view of the surrounding country. But there are plenty of burrows in the heaviest soil of the creek-bottoms. They dislike stony places for obvious reasons, yet they will often burrow beneath a single large rock. I have also found nearly horizontal holes of theirs dug from the face of an almost perpendicular bank. In short, there is endless diversity in the details of their habitations.

Of the underground life of the gophers I suppose no one knows much—certainly I do not. I am inclined to think the animals are essentially polygamous, which is a point to be considered in the question of the occupancy of the burrows. If they regularly paired, I think sufficient indication of the fact would not have escaped me. But I saw no signs of this occupation of a burrow by a pair. One gopher to a hole is the universal rule; that is, one gopher to an occupied hole. For the animals are very in-

dustrious, and in every thickly peopled region, the number of deserted burrows is out of all proportion to those in use. That not only the breeding female, but every other individual has his own domicile, cannot, I think, be doubted; and they appear to guard the gates jealously. For whenever, in the hurry of a sudden alarm, two or more gophers rush into the same hole, there is sure to be trouble. We hear, if we are near enough, a squeaking and commotion below, and the intruders are pretty sure to betake themselves off as soon as they dare. Doubtless different holes are put to different uses. The female must have her bed in which to be confined and rear her young. The male his permanent retreat. Some of the holes are storehouses. Then, I am persuaded, a great many of the shallower burrows are dug for temporary refuge and soon abandoned; for the gopher is an exceedingly timid animal, and must have a convenient place to hide. The storehouses I have discovered by accident and examined at my leisure. In places where small streams work through light soil, they continually form "cut-banks" along their convexities. By this undermining and fall of earth, burrows are frequently exposed. The storehouses I have seen were merely an enlarged excavation at the end of the passage, containing a hatful of the husks of grass seeds and the like.

There is one very curious point in the socialism of these animals. Every now and then, in odd out-of-the-way places, where there may not be another gopher for miles perhaps, we come upon a solitary individual guarding a well-used burrow, all alone in his glory. The several such animals I have shot all proved to be males; and what is singular, these old fellows are always larger than the average (some would weigh twice as much), peculiarly sleek and light-colored, and enormously fat. The earlier ones I got I suspected to be a different species, so peculiar were they in many respects. I suppose they are surly old bachelors who have foresworn society for a life of indolent ease, though if I had found them oftener among their kind I should have taken them for the Turks of the harem. It seems to be a case somewhat parallel with that of the lonely old buffalo bulls so often met with away from the herd.

The female brings forth in June. This I infer, at least, from the circumstance that July brings us plenty of young ones two-thirds grown. The young probably keep closely in the burrow until they

are of about this size — I do not remember to have seen any smaller ones running about. Without having seen a litter in the nest, I should judge the number of young produced at a birth to be about eight; at any rate, the female has constantly ten[2] teats; and July specimens, in worn harsh pelage, with all or nearly all of the teats in use, are frequently secured.

Of the life of the animal during the winter I know positively nothing. But two things are assured. They do not migrate, and they are not seen abroad. They must hibernate, and pass most of the long inclement season in a state of torpor. Such supplies of food as I have spoken of would not last an active animal so long.

However this may be, the gathering and hoarding of seeds seems to be their principal occupation during the summer. Amidst thousands that we pass only to see them skurry into their holes in trepidation, there are necessarily some observed which do not notice us, or at any rate do not take alarm. I have often watched them, where the grass was taller than usual, gathering their store. They rise straight up on their haunches, seize the grass-top, and bite it off. Then settling down with a peculiar jerk, they sit with arched back, and stow away the provender in their pouches with the aid of their fore paws. Their cheek pouches are not very large — both together would hardly hold a heaping teaspoonful. When duly freighted they make for their holes. Their mode of feeding, as they do, upon grass-blades or any other herbage, as well as upon seeds, is essentially the same. In their foraging excursions, they seem to have regular lines of travel. From almost every long-used hole may be seen one or more little paths, an inch or two wide, sometimes so well worn that they may be traced fifteen or twenty feet. These paths often run from one hole to another. No matter how smooth the ground, these paths are never quite straight; they repeat in miniature the devious footpath across the meadow, the mysterious something that prevents an animal from walking perfectly straight being in force here.

Though properly a vegetarian, like other rodents, the gopher is fond of meat, and I think that no small share of his summer's food is derived from the carcasses of buffalo. Wolves do not appear to be numerous, in summer at least, in this region, and the

[2] One pair axillary, one pair pectoral, two pairs abdominal and one pair inguinal.

polishing of buffalo skeletons is largely accomplished by the kit foxes, badgers, skunks and gophers. Hard by a slain buffalo a badger's hole is pretty sure to be soon established, together with a number of temporary gopher burrows. In proof positive of this carnivorous propensity, I have more than once seen the inside of a drying carcass completely covered with the peculiar and readily-recognized excrement of the gophers, while the bones and flesh were gnawed in a way that plainly told who had been there. The excrement is conico-cylindric, and thus very different from that of rabbits, the only other common rodents of the region.[3]

The voice of the gopher is peculiar — quite unlike the harsher and more guttural "barking" of the prairie dog. It is a sharp, wiry squeak of less volume, and is pitched in a higher key, than might be expected in the case of an animal of its size. It is a single note, repeated a few times. Comical as a gopher is in some of his attitudes and motions, he never looks so funny as when squeaking. He generally gets down on all fours to it, drops his jaw with a jerk, and squeezes out the noise by drawing in his belly — it reminds one of a toy dog. If caught or wounded, they have an energetic chattering outcry, much like that of other species.

There is not the slightest difficulty in securing any desired number of specimens — as is *not* the case with the prairie dog. Though equally timid, the gopher is neither so suspicious nor so warily cautious; nor is it so tenacious of life. As is well known, the chances are largely against securing a prairie dog shot at the mouth of his burrow. No matter how badly wounded, he generally manages in his death struggles to work down out of reach, and he not seldom, when shot dead, falls out of sight. But I would readily undertake to secure half the gophers fired at when fairly in sight, no matter if they were directly over the hole. Moreover a prairie dog, scared into his hole, will scarcely show his nose for a long time, while a gopher, more inquisitive or less prudent, generally pops up again in a few moments, to have another look, and vent his displeasure in a series of energetic squeaks. Advantage may be taken of this trait to secure him alive, by simply setting a noose around the hole, and retiring to a little distance, jerking the string smartly the moment the little animal's

[3] On slightly everting the anus (both sexes), there are seen three prominent conica papillæ around the margin, just inside — one anterior and one on each side.

nose appears. He is generally caught by the neck or around the chest. The soldiers used to have great fun this way sometimes, and I know of one man catching seventeen in about an hour. Fishing for gophers may not be very thrilling sport, but I should think, though I never tried it myself, that it would be quite as exciting as some other styles of angling.

I wish I could do justice to the rest of my subject — I mean to the variety of tricks and funny ways there are about a gopher, and without which no gopher is complete. But a gopher must be seen, and seen often, to be appreciated. For instance, a gopher caught away from home is a very different animal from one at the mouth of his hole. A most unreasonably timid animal, considering how rarely he is molested, he never goes out without feeling that he has taken his life in his hands. A thoroughly scared gopher is the liveliest object in nature; a mule kicking over the traces is perfect repose in comparison. He doubles up and opens out like nothing else I know of, with his absurd little whisk of a tail hoisted, and the way he gets over the ground without once looking back is amazing. Safe home, be he never so badly frightened, he will stop to see what was the matter. He pops bolt upright, stands stock still with his fore-paws drooped affectedly in front of him, looks demurely around, and squeaks out "Pooh! who 's afraid?" as plainly as possible. But let one come a step nearer, and down he goes on all fours, right over the hole, where he sits and scolds with back arched up, ready for a dive. When he does finally duck out of sight, there is no mistaking his meaning; the suggestive flirt of his tail, the last thing seen, speaks volumes to a thoughtful observer.

But one must not too hastily conclude that a gopher on the prairie is always in a flurry, or that one at home is always saucy. On the contrary, like other frolicsome, heedless little creatures they are sometimes wofully imprudent, and will gambol about almost at one's feet, or enter a tent to forage for food. They are the life of the prairie, and they have afforded, to me at least, no little real pleasure. I like to watch them undisturbed, they are such pretty, sleek, comfortable creatures, so full of life, so busy, so bright. They always look as if they would like to know you better if they dared, and when they give you up as an impossibility, they go off in zigzag with mincing steps, stopping every few paces, half inclined to come back after all. A gopher never quite

polishing of buffalo skeletons is largely accomplished by the kit foxes, badgers, skunks and gophers. Hard by a slain buffalo a badger's hole is pretty sure to be soon established, together with a number of temporary gopher burrows. In proof positive of this carnivorous propensity, I have more than once seen the inside of a drying carcass completely covered with the peculiar and readily-recognized excrement of the gophers, while the bones and flesh were gnawed in a way that plainly told who had been there. The excrement is conico-cylindric, and thus very different from that of rabbits, the only other common rodents of the region.[3]

The voice of the gopher is peculiar — quite unlike the harsher and more guttural "barking" of the prairie dog. It is a sharp, wiry squeak of less volume, and is pitched in a higher key, than might be expected in the case of an animal of its size. It is a single note, repeated a few times. Comical as a gopher is in some of his attitudes and motions, he never looks so funny as when squeaking. He generally gets down on all fours to it, drops his jaw with a jerk, and squeezes out the noise by drawing in his belly — it reminds one of a toy dog. If caught or wounded, they have an energetic chattering outcry, much like that of other species.

There is not the slightest difficulty in securing any desired number of specimens — as is *not* the case with the prairie dog. Though equally timid, the gopher is neither so suspicious nor so warily cautious; nor is it so tenacious of life. As is well known, the chances are largely against securing a prairie dog shot at the mouth of his burrow. No matter how badly wounded, he generally manages in his death struggles to work down out of reach, and he not seldom, when shot dead, falls out of sight. But I would readily undertake to secure half the gophers fired at when fairly in sight, no matter if they were directly over the hole. Moreover a prairie dog, scared into his hole, will scarcely show his nose for a long time, while a gopher, more inquisitive or less prudent, generally pops up again in a few moments, to have another look, and vent his displeasure in a series of energetic squeaks. Advantage may be taken of this trait to secure him alive, by simply setting a noose around the hole, and retiring to a little distance, jerking the string smartly the moment the little animal's

[3] On slightly everting the anus (both sexes), there are seen three prominent conica papillæ around the margin, just inside — one anterior and one on each side.

nose appears. He is generally caught by the neck or around the chest. The soldiers used to have great fun this way sometimes, and I know of one man catching seventeen in about an hour. Fishing for gophers may not be very thrilling sport, but I should think, though I never tried it myself, that it would be quite as exciting as some other styles of angling.

I wish I could do justice to the rest of my subject — I mean to the variety of tricks and funny ways there are about a gopher, and without which no gopher is complete. But a gopher must be seen, and seen often, to be appreciated. For instance, a gopher caught away from home is a very different animal from one at the mouth of his hole. A most unreasonably timid animal, considering how rarely he is molested, he never goes out without feeling that he has taken his life in his hands. A thoroughly scared gopher is the liveliest object in nature; a mule kicking over the traces is perfect repose in comparison. He doubles up and opens out like nothing else I know of, with his absurd little whisk of a tail hoisted, and the way he gets over the ground without once looking back is amazing. Safe home, be he never so badly frightened, he will stop to see what was the matter. He pops bolt upright, stands stock still with his fore-paws drooped affectedly in front of him, looks demurely around, and squeaks out "Pooh! who 's afraid?" as plainly as possible. But let one come a step nearer, and down he goes on all fours, right over the hole, where he sits and scolds with back arched up, ready for a dive. When he does finally duck out of sight, there is no mistaking his meaning; the suggestive flirt of his tail, the last thing seen, speaks volumes to a thoughtful observer.

But one must not too hastily conclude that a gopher on the prairie is always in a flurry, or that one at home is always saucy. On the contrary, like other frolicsome, heedless little creatures they are sometimes wofully imprudent, and will gambol about almost at one's feet, or enter a tent to forage for food. They are the life of the prairie, and they have afforded, to me at least, no little real pleasure. I like to watch them undisturbed, they are such pretty, sleek, comfortable creatures, so full of life, so busy, so bright. They always look as if they would like to know you better if they dared, and when they give you up as an impossibility, they go off in zigzag with mincing steps, stopping every few paces, half inclined to come back after all. A gopher never quite

knows his own mind. But the prettiest of all the exhibitions a gopher can make of himself, is when he frames his profile in the rim of his burrow. Not seldom, after running some little fellow to earth, have I stood still just by the hole, and confidently waited for his reappearance. Presently I hear a little scratching, perhaps a squeak, and then I see his head, turned roguishly to one side, to throw one bright black eye full upon me, as if to ask what manner of creature I may be to stand thus boldly at his door. He looks as if he would like to invite me in, and then laugh at me for being too big and too clumsy to enter.

A STATE SURVEY FOR MASSACHUSETTS.

BY PROF. N. S. SHALER.[1]

While Hayden with his score of coadjutors is skirmishing over the unexplored recesses of the West, reconnoitring an empire in a season, the surveyors of Great Britain are patiently unriddling their islands at a rate that will require a century for its completion.

It must not be supposed because these two kinds of workers differ so widely in their methods that either is mistaken. Each is doing legitimate work in its sphere, and each has its important scientific and economic results. Perhaps the best specimen of this system of reconnoissance work which has ever existed is now in operation in this country, under the charge of Dr. Hayden; other expeditionary surveys under the charge of Mr. Clarence King and Major Powell, have shared with Hayden the task of unravelling the complicated geology and topography of the vast area lying between the eastern and western borders of the Cordilleras of North America. The present system pursued by Hayden is admirably suited to secure the most rapid delineation of a country for correct sketch maps. A system of triangles is carried across country from mountain-top to mountain-top, so that a large number of positions are accurately determined. From good points of view the topographer delineates the intermediate country by the

[1] The following extracts are taken from an article in the "Atlantic Monthly" for March. We regret that we have not space to reprint the article entire, as it forms an admirable presentation of the subject of surveys in general. — Eds.

use of the theodolite; contour lines, or lines supposed to represent equal heights above a water level, are sketched in with some detail, so that the eye catches the true reliefs of the country. Along with these topographical parties go geologists and collectors of specimens, to illustrate the geology and biology of the country. This survey is carried on at such speed that in a season of four or five months a single party will work in several thousand square miles of territory and obtain a remarkably good idea of all its important features. Several of such parties together make up the expedition, and the reports set forth, with a fair accuracy, the topography, geology, zoölogy, botany, agricultural resources, and such information as can be gained concerning the climatology of the district surveyed. It is difficult to imagine a plan better calculated than this to accomplish the end in view, namely, to discover the general characters of an unexplored land, and to guide the coming immigrant in its development by the steady light of science.

The state of Massachusetts is a remarkably favorable state for illustrating the methods in which a survey should be conducted; not such a survey as a new Western State makes in order to get some idea of where its coal and iron lie, and the amount of its wealth, but a work intended to be the most exact and final work which it is possible to do on the earth's surface. When a government approaches so considerable an enterprise as this, and determines that it is to be done so as never to require, in our day at least, a reconstruction, all geologists will agree that the first thing is to secure the best map. Massachusetts has the good fortune to have her shore-belt map completely made by the Coast Survey; Cape Ann and Cape Cod and the bordering islands, making, together, about a tenth of the total area of the state, have all been done on the scale of one ten thousandth, or about six inches of map to the mile of distance. If it were practicable, this map should be continued on the same scale over the whole state, making, when finished, a record map about ninety feet long and fifty-four wide; on this scale every important detail could be truthfully laid down. This is the proper thing to do, and nothing but the cost of the work can be urged against it; on this plan the surveying and improvement of private grounds could always be accomplished, tax-levies made, in short, our civilization could be organized upon it. If something else less perfect must be done, it will be with the greatest regret that we turn to it from our ideal.

On this perfect system the topography alone would be likely to cost over half a million of dollars and pretty certain not to exceed three-quarters of a million, or about as much as one thousand feet of the Hoosac Tunnel. Who will say that Massachusetts cannot afford this sum for a perfect record of the theatre of her industries? If, however, it be thought that it is better to temporize with the matter, it will certainly be possible to get the most important results with a smaller original map — one twenty-five thousandth, or about two and a third inches to the mile, will answer for most of the great economic purposes of a survey; it will not, however, serve as a tax map or for the management of individual estates, and in time it would have to be done over on the larger scale. The dimensions of the original maps, it should be noted, is quite another matter from the size they have in their published form; from the original records reductions can be made to any scale.

When this topography is far enough advanced to give a basis for other work, the geology and biology should be taken in hand. Here we come upon a class of researches which require some special consideration. What should be the objects of this scientific work, and how are these objects to be attained? To answer these questions at length is to discuss all the methods and aims of science. There are some limitations, however, which are worthy of note. Any state, however small, furnishes problems organic and inorganic, which will require centuries for their complete discussion. As we do not propose that a survey shall take up at once all the problems of science, it becomes a nice matter to limit the work. In the geology this is comparatively easy; no amount of detail consistent with the condition of the science will be superfluous here; every stratigraphical question, every question in chemical geology, should be followed to its utmost point. Each region supplies the investigator with special problems which he knows whenever the general structure of a country is known; it is the special object of a reconnoissance to show what and where these problems are. Some of them are economical, have money in them; the others are economical too, in that higher sense which finds all truth profitable. Of those which connect themselves immediately with industry we may mention the following questions: (1) the distribution of water, its storage and quality; (2) the building-stones of the state; (3) the existence of deposits of coal in workable quantities; (4) the distribution of metals, the iron of the

western region, and the silver-bearing beds of the east; (5) the reclamation of marshes; (6) the retimbering of the exposed parts of the coast. Among the scientific problems, the state affords some matters of surpassing interest. Probably no other known fossils have so much value for the science of to-day as those wonderful footprints of the Connecticut Valley. They deserve years of study and the thorough investigation which can only be given by a careful re-survey of the whole region.

Among the many problems concerning the existing life of the state, it is difficult to give in a word the most important. A large part of the necessary work for the complete description of our animals and plants is already done, and needs but to be assembled and ordered. The state is already rich in investigators, and as soon as a survey begins, these will be increased; from their labors we may hope for a thorough study of the biology of Massachusetts. The state has already taken advanced ground concerning instruction in natural history. It will greatly aid the work of diffusing a knowledge of nature throughout the people, to have carefully edited catalogues of all the animals and plants existing within the state, with enough concerning their characters, habits, etc., to make the information of practical value to beginners. This work need be of very little expense to the survey; the state already has nearly a million of dollars invested in the Museum of Comparative Zoölogy, and in the work of cataloguing the animals this noble institution can make a substantial return through the students it has trained and the collections it has accumulated. Managed with discretion, this survey could not fail to bring about a great interest in science in our public schools of all grades. With good maps and good catalogues of the natural productions of a country, the teaching of natural science becomes possible to a degree that cannot be hoped for under other circumstances. This is to Massachusetts a matter of great importance; her real greatness has lain and always must lie in her power to produce men preëminently fitted for the work of their day. Other states can, almost without effort, beat her in the race for material greatness, strive as she may against it; but her intellectual lead, now so clearly established, may be maintained to the end if she but care to take the steps necessary to keep her energies bent towards this object. She must now foster science as she has established and fostered theology and general learning.

THE MODE OF GROWTH OF THE RADIATES.

BY A. S. PACKARD, JR.

I. THE HYDROIDA.

THE animal next higher in structure than the sponge is the curious Protohydra discovered by Greef among diatoms and seaweeds in the oyster park at Ostend. It is regarded by Greef as the marine ancestral form of the Cœlenterates (Hydroids, Jelly fishes and Actiniæ). It is the simplest possible radiate form yet discovered. As the form of the fresh-water Hydra is familiar, Protohydra may be best described as similar to that, except that it is entirely wanting in tentacles. Like Hydra it is made up of two layers (an ectoderm and endoderm), with a mouth and stomach (gastro-vascular cavity). Nothing is known of its history, though Greef is positive that it is not a young Actinia.

The next highest form is the fresh-water Hydra, which is commonly found on the under side of the leaves of aquatic plants. This well known animal is the simplest form of the division of radiates known as Hydroids. The somewhat club-shaped body consists of two layers, the inner (endoderm) lining the general cavity of the body, which serves both as mouth and stomach and for the circulation of the nutritive fluid, and is called the gastro-vascular cavity. The mouth is surrounded with eight tentacles, which are prolongations of the body-wall and are hollow, communicating with the body cavity.

Such is the general structure of the Hydra. In the ectoderm are situated the lasso-cells or nettling organs, being minute barbed filaments coiled up in a cell-wall. From Kleinenberg's recent researches on the Hydra it appears that there are scattered irregularly through the endodermal lining of the body-cavity isolated ciliated cells. They do not form a continuous lining membrane, and thus bear an interesting analogy to the ciliated cells of the sponge. While the endoderm forms a simple cell-layer, the outer layer (ectoderm) is more complex, as just within an external simple layer of large cells is a multitude of smaller cells, some of them being thread or lasso cells, while still within are fine muscular fibrillæ which form a continuous layer. The large cells first

named end in fibre-like processes, which alone possess contractility and are thought by Kleinenberg to be motor-nerve endings. These large cells, from combining the functions of muscle and nerve, are termed "nervo-muscle cells." The little cavities between the large endodermal cells and the muscular layer which lies next to the endoderm is filled with small cells and lasso-cells, forming what Kleinenberg calls the interstitial tissue. From this tissue are developed the eggs and spermatozoa.

The organization of all the hydroids and even Lucernaria and the larger jelly-fishes (Discophora) is based on the plan of the Hydra. They all have a simple body-cavity, but no true alimentary canal surrounded by a perivisceral cavity. This is the distinguishing character of the Cœlenterates. In the jelly-fishes, the often complicated water vascular system of canals are simply passages leading out from the axial gastro-vascular cavity. If we place a jelly fish in the same position as the Hydra, *i.e.*, with the tentacles directed upwards, the general homology between the parts can be clearly traced. In the Hydroids, such as Sertularia, etc., the ectoderm is surrounded by a chitinous sheath, secreted from this layer. While in Hydra the young bud out from the side of the body, in the Hydroids the young are developed on a separate stalk from the barren or nutritive stalk or "zooid." The individual Hydroid is thus subdivided into a reproductive and a nutritive zooid. The reproductive zooids seldom or never take in food, but are nourished by the nutritive zooids, the two zooids being connected by a common creeping stem called the "cœnosarc."

The Anthozoa or sea anemones and coral polypes differ from the Hydroids and Medusæ in having the stomach open at the bottom into a second and larger cavity communicating with the radiating chambers. In the Ctenophora there is a decided approach in the complication of the body to the Echinoderms. The radiated structure so clearly shown in the lower forms is here in part subordinated to the bilateral arrangement of parts; they have a right side and a left side. They also differ in the mouth opening into a wide digestive cavity, enclosed between two vertical tubes, uniting at the end of the body, where the stomach forms a reservoir for the gastro-vascular tubes ramifying throughout the body. They move by a peculiar apparatus consisting of bands of comb-like flappers. Not detaining the reader with a definition of the subdivisions of the Cœlenterates we shall be content with

giving the following tabular view of the lowest subdivision of Radiates:—

CŒLENTERATA.

ACALEPHS OR HYDROZOA.
1. *Hydroïda.* *a.* Hydriform (Hydra, Hydractinia, Tubularia, Sertularia)
b. Siphonophora (Velella, Agalma, Physalia).
2. *Calycozoa* (Lucernaria).
3. *Medusæ* or *Discophoræ* (Aurelia.)
ANTHOZOA (Actinia, Cerianthus, Astræa, Alcyonium, Gorgonia and Renilla).
CTENOPHORÆ (Beroë, Cydippe, Cestum).

Development of Hydra and the Hydroids. Ehrenberg first showed that the Hydra reproduced by eggs which become fertilized by spermatic particles. Kleinenberg describes the testis, which is lodged in the ectoderm and which develops tailed spermatozoa like those of the higher animals. They arise, as in other higher animals, from a self-division of the nuclei of the testis-cells. There is a true ovary formed in the same interstitial tissue of the ectoderm, consisting of a group of cells, which differ entirely in their mode of formation from the ovaries (gonophores) of the marine Hydroids, which are genuine buds.

It thus seems that Hydra is monœcious or hermaphrodite, *i. e.*, the sexes are not distinct. The egg of Hydra originates from the central cell of the ovary; thus confirming the opinion now generally held that all animals as a rule arise from a simple cell. After the egg-cell has escaped from the ovary through the ectoderm, it still holds on by a narrow point to the sides of the Hydra, where it is fecundated by the spermatic particles discharged into the surrounding water from the testis.

Fecundation is succeeded by a true segmentation of the egg. The young Hydra thus passes through a true "Morula" stage.[1] There is an outer layer of prismatic cells, forming the surface of the germs, and surrounding the inner mass of polygonal cells. At first none of these cells are nucleated, but afterwards nuclei appear, and it is an important fact that these nuclei do not arise from any preëxistent egg-nucleus.

The next step is the formation of a true chitinous shell, enveloping the germ or embryo. After this Kleinenberg asserts that the cells of the germ become fused together, and that the germ is like an unsegmented egg, being a single continuous mass of protoplasm. Allman remarks that "as this phenomenon does not occur

[1] Hereafter we shall often use Hæckel's convenient term "Morula," instead of "stage of segmentation of the egg," for the sake of brevity.

in other Hydroids it can have no general significance for the development of the order."

The remaining history of Hydra is soon told. In this protoplasmic germ-mass there is formed a small excentric cavity; this is the beginning of the body-cavity, which finally forms a closed sac. Allman remarks on this discovery of Kleinenberg's that "it is clear that the formation of a body cavity by invagination of the walls [*i. e.*, ectoderm] with the significance which Kowalevsky has assigned to it in other animals, does not exist in Hydra, and just as little will it be found in any other hydroid." It will be seen farther on that in certain medusæ, Kowalevsky has discovered that the digestive cavity is formed by the invagination of the ectoderm, and we have seen (p. 107) that Metznikoff declares that the ciliated cells lining the gastro-vascular cavity in the embryo of the sponge are the originally external ciliated cells of the planula withdrawn into and lining the body cavity.

After several weeks the germ bursts the hard shell and escapes into the surrounding water, but is still surrounded by a thin inner shell. After this a clear superficial zone appears, and a darker one beneath, which is the first indication of the splitting of the germ into the two definitive germ-lamellæ, common to all animals except the one-celled Protozoa.

The embryo soon stretches itself out, a star-shaped cleft appears, which forms the mouth. The tentacles next appear. The animal now bursts open the thin inner shell, and the young Hydra appears much like its parent form.

There is, then, no metamorphosis in the Hydra; no ciliated planula. The adult form is thus reached by a continuous growth.

It will be seen, to anticipate somewhat, that the Hydra, exactly as in the vertebrates, including man, arises from an egg developed from a true ovary, which is fertilized by a true tailed spermatic particle; that the egg passes through a morula stage; that the germ consists of two germinal layers, while from the outer layer, as probably in the vertebrates, an intermediate or nervo-muscular layer is formed, which Allman thinks is the homologue of the middle germ-lamella of the vertebrates, supposed to have originally split off from the ectoderm. Allman even regards the chitinous shell of the germ of Hydra as the equivalent of the epidermis of vertebrates, being a provisional embryonic organ in Hydra, but permanent in vertebrates.

In all the marine Hydroids, which are more complex in their individualism than Hydra, the sexes being separate, the eggs and spermatic particles are thought by Allman to be developed from the endoderm. But E. Van Beneden has on the other hand shown that the eggs in Hydractinia are exclusively developed from the endoderm, while the spermatic cells arise from the ectoderm.

The simplest form next to Hydra is Hydractinia, in which the individual is differentiated into three sets of zooids; *i.e.*, *a*, hydra-like, sterile or nutritive zooids; *b* and *c*, the reproductive zooids, one male and the other female, both being much alike externally, having below the short rudimentary tentacles several spherical sacs, which produce either male or female medusæ. These medusa buds or closed generative sacs are fundamentally like the free medusæ in structure. The marine Hydroids, then, are universally diœcious, and usually each colony is either male or female.

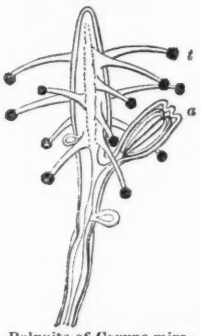
A rather more complicated form is the common *Coryne mirabilis*. Fig. 51 shows the hydrarium with its long tentacles (*t*) and *a* the medusa buds, Fig. 52 its free medusa. Tubularia is a higher form, and allied to the latter is still another form, *Corymorpha pendula* (Fig. 53. After Agassiz).

Figs. 54–58 (after A. Agassiz) represent quite fully the life history of another Tubularian, *Bougainvillia superciliaris*. Fig. 54 represents the hydrarium, with the sterile zooids provided with long tentacles, and the medusa buds of different ages. Fig. 55 shows a bud still more enlarged, with the proboscis (manubrium) just formed, and knob-like, rudimentary tentacles. In an older stage (Fig. 56) the proboscis is enlarged and the tentacles lengthened, while the depression at the upper end indicates the future opening. In Fig. 57 the appendages of the proboscis are plainly indicated, the tentacles are turned outwards. Shortly after this the jelly-fish breaks loose from its attachment and swims around as at Fig. 58.

How do the zooids first arise? This leads us to speak of the simplest mode of reproduction in the Hydroids, which is by budding. The object of sexual reproduction, *i. e.*, by eggs and spermatozoa, throughout the animal and plant world, is by bringing the germ or portion of protoplasm of one individual, which is an epitome potentially of its physical and psychical nature, to mingle with that of another of the same species, so that the offspring may combine the qualities of both parents, and not deteriorate. The

species can be reproduced simply by budding, but the result would, if maintained for a number of generations, in the end prove disastrous to its integrity. Nature abhors self-fertilization. So that while, as in these Hydroids, the zooid form may be produced by budding, yet the time comes when the individuals of one colony must mingle their reproductive elements with those of a remote colony, through the medium of the water. By this mode of repro-

Fig. 51.



Polypite of Coryne mirabilis, with a bud below *a*, and medusa bud, (gonophore) above. *a*, much enlarged. After Agassiz.

Fig. 52.

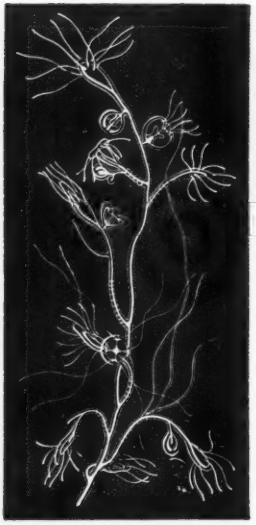
Free medusa of Coryne thrown off from the gonophore. Natural size. After Agassiz.

Fig. 53.

Corymorpha.

duction new colonies are also set up. On the other hand budding or gemmation has for its object the extension of the colony of nutritive and reproductive zooids. This alternation of budding with sexual generation or "alternation of generations," or "parthenogenesis," is first met with in the Hydroids, and we shall find it often recurring in the higher animals when needed to meet some special exigency of the species.

Fig. 54.



Hydrarium of Bougainvillia, magnified.

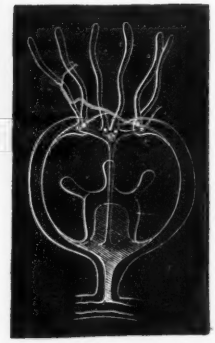
Fig. 56.

Medusa bud of 54, farther advanced.

Fig. 55.

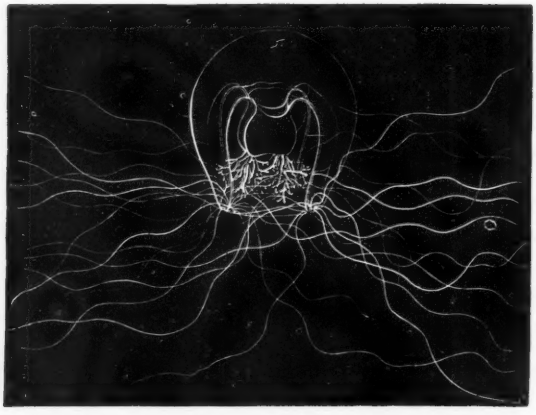
Medusa bud of 54.

Fig. 57.



Medusa bud with the tentacles turned out. Magnified.

Fig. 58.



Medusa of Bougainvillia. Magnified. After A. Agassiz.

Budding begins as a slight protrusion of the basal portion (cœnosarc) of the colony, which then becomes spherical and finally club-shaped, as in Fig. 51, until it assumes the form of a zooid. It remains permanently attached in all the Hydroids except in Hydra, where it breaks off and bears a free individual. In some species of Tubularia the heads of the zooids successively drop off, and are renewed.

Multiplication by fission has only been observed in one case, in the medusa of Stomobrachium, observed by Kölliker at Messina. In this the pendent stomach divided in two, becoming doubled, which was followed by a vertical division of the umbrella, separating the animal into two independent halves. These again subdivided, and Kölliker thinks this process went on still farther.

The second mode of generation, *i. e.*, by eggs and spermatic particles, have been observed in many marine Hydroids. As in the Hydra, the eggs, after being fertilized, pass through a morula stage, and finally the germ becomes surrounded by a blastoderm, as in Hydra, formed of long prismatic cells directly comparable with the zone of blastodermic cells of insects, and many other animals, including the mammals. The germ elongates and finally escapes from the ovisac (gonophore) of the parent as a ciliated "planula," a term first applied to it by Dalyell.

Now how do these planulas become converted into hydras, and through them into medusæ? A glance at the accompanying figures will give the main points in the life history of a not uncommon Hydroid found on our shores, a Melicertum allied to Campanularia (Fig. 62). We are indebted to Mr. A. Agassiz (Seaside Studies in Natural History) for the following facts and illustrations regarding its history. After keeping a number of the Melicertum in a large glass jar for a couple of days at the time of spawning, he found that the ovaries, at first filled with eggs, became emptied, and that the planulæ, at first spherical and afterwards pear-shaped (Fig. 59) swam near the bottom of the jar, and soon attached themselves by the larger end to the bottom of the jar (Fig. 60). "Thus their Hydroid life begins; they elongate gradually, the horny sheath is formed around them, tentacles arise on the upper end, short and stunted at first, but tapering rapidly out into fine, flexible feelers; the stem branches, and we have a little Hydroid community (Fig. 61), upon which, in the course of the following spring, the reproductive calycles containing the medusæ buds will be developed."

Fig. 59.

Planula of Melicertum.

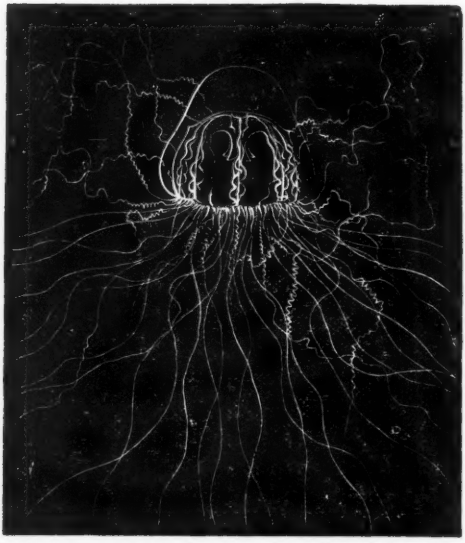
Fig. 60.

Cluster of Planulæ just attached to the ground.

Fig. 61.

Polypites of Melicertum developed from the planulæ; greatly magnified.

Fig. 62.



Melicertum campanula, seen in profile. Natural size. After Agassiz.

Coming now to the Portuguese man-of-war (Physalia) which have so much occupied the attention of the best naturalists, it would seem at first well nigh impossible to trace their relationship with the ordinary Hydroids. A Physalia may, however, be compared to a fixed colony of Hydractinia or Coryne, for example. Each Physalia is either male or female, and consists of four kinds of zooids; viz., nutritive and reproductive, with medusa buds, which, by their contractions and dilatations propel the colony onward; and the "feeders," a set of digestive tubes which nourish the entire colony.

The Siphonophores (as observed by Gegenbaur, Kowalevsky, Hæckel and Metschnikoff, in Agalma and several other genera) arise from eggs which pass through a morula stage, into a ciliated planula, whose body consists of an ectoderm and endoderm. The gastro-vascular cavity in the Siphonophores, as in the lower Hydroids so far as observed, is formed by a fold of the endoderm, while, as we shall see farther on, in the Discophorous jelly fishes it is formed by an infolding of the ectoderm.

The further development of Nanomia, a Siphonophore native to our northern shores, from the larval state, has been described and figured by Mr. A. Agassiz. To use nearly his own words, the Nanomia consists, when first formed, of an oblong oil bubble, with but one organ, a simple digestive cavity. Soon between the oil bubble and the cavity arise a number of medusa buds, though without any "proboscis" (manubrium), as these medusa buds, called "swimming bells," are destined to "serve the purpose of locomotion only, having no share in the function of feeding the community." After these swimming buds, three kinds of Hydra-like zooids arise. In one set the Hydra is open-mouthed, and is in fact a digestive tube, its gastro-vascular cavity connects with that of the stem, and thus the food taken in is circulated throughout the community. These are the so-called "feeders." The second set of Hydras differ only from the "feeders" in having shorter tentacles twisted like a corkscrew. In the third and last set of Hydras the mouth is closed, and they differ from the others in having a single tentacle instead of a cluster. Their function has not yet been clearly explained. Gradually new individuals are added, until a long chain of Hydroids is formed, which move gracefully through the water, with the oil globule uppermost, which serves as a float and is identical with the large-crested "float" of the Physalia.

Finally, the higher Hydroids, such as Æginopsis, Ægineta Cunina and Lyriope have been found by Muller, Agassiz, McCrady, Leuckart, Gegenbaur, Fritz Muller and others, to develop directly from eggs and pass through a metamorphosis as medusæ. During the past year (1874) Metschnikoff has published, with many figures, an account of the development of Geryonia, Polyxenia (Ægineta) and Æginopsis.

In these animals the egg passes through a morula stage; an outer layer of cells (blastoderm) splits off from the morula, forming the ectoderm and entoderm. The embryo, then, as in Polyxenia, passes through a ciliated planula stage. The embryo may remain spherical, as in Geryonia, or as in Polyxenia and Æginopsis, the body of the planula becomes greatly elongated and bomerang-shaped, and from each end are developed the first two tentacles, then others, and after a slight metamorphosis the adult form is attained.

The life history of the Hydroids comprises, then, the following phases in development:—

1, *a*. Origin of young Hydra by budding.
   b. Origin of embryo from egg fertilized by spermatozoa.
2. Morula stage.
3. Planula (Gastrula) stage.
4. Hydra-like form, attached.
5. Medusa, free and discharging eggs.

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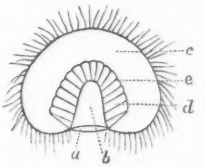
II. THE MEDUSÆ (Discophoræ).

Passing by the Lucernaria, beautiful and interesting, but of whose early development we know nothing, we come to the common

larger jelly-fishes of our shores, which differ from the bell-shaped hydroid medusæ in their usually larger size and solid disk, as well as in the larger number and greater complication of the water tubes, which ramify and interbranch along the under side of the disk; and in carrying their eggs in pouches. In our common *Aurelia flavidula* there are four of these large pouches occupying the centre of the disk.

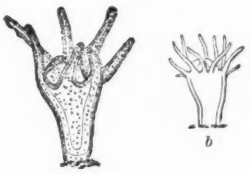
The life history of the Aurelia, which we will select as an example of the mode of development of this group, since it is best known, is far less complicated than that of the Hydroids. The ciliated planulæ may be found in the egg pouches of the female Aurelia during the last of summer. Soon after the ectoderm and entoderm are formed, a mouth is developed, and a gastro-vascular cavity is formed by the invagination of the ectoderm, as stated by Metschnikoff, and they then pass into a gastrula (planula) stage (Fig. 63, Gastrula of a form allied to Aurelia; *a*, mouth; *b*, gastro-vascular cavity; *c*, ectoderm; *d*, entoderm; after Metschnikoff), with a mouth and long digestive cavity. After swimming about for a while they fix themselves to some object at the bottom of the sea and soon a

Fig. 63.



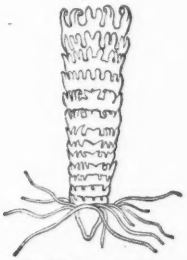
Gastrula of an Aurelia-like Medusa.

Fig. 64.



Scyphistoma of Aurelia, at different ages. Magnified.

Fig. 65.



Strobila of Aurelia.

pair of tentacles begin to develop, and then two more, until not more than sixteen are developed. When of this hydra-like form (Fig. 64 *a*, young; *b*, older, after A. Agassiz) it is called a "Scyphistoma," having originally, as well as the Strobila and Ephyra,

been mistaken forand described as an adult animal under that name.

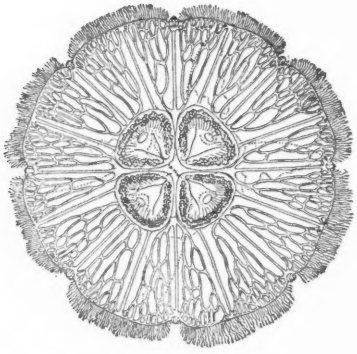
After assuming this scyphistoma condition, transverse constrictions appear at regular intervals, dividing the column, as it were, into a pile of saucers; the edges rise, tentacles bud out, and the animal assumes the form seen in Fig. 65 (after Agassiz). The uppermost disk becomes detached, the rest separate one after the other and float away in the form of an "Ephyra" (Fig. 66, after A. Agassiz) and after some weeks assume the aurelia or adult condition (Fig. 67). The gigantic *Cyanea arctica*, which attains a diameter of from three to five feet across the disk, as Agassiz remarks, is produced from "a hydroid measuring not more than half an inch when full-grown."

Fig. 66.

Ephyra of Aurelia.

On the other hand there are several exceptions known to this mode of development, a few growing directly from the egg, with-

Fig. 67.



Aurelia flavidula. After Agassiz.

out passing through a hydra, or scyphistoma stage. Such is the large Pelagia, as observed by Krohn. Mr. A. Agassiz has observed the same fact in *Campanella pachyderma*, a minute jelly fish.

The Discophores, then, develop in two ways:—

A. Directly from the egg (Pelagia and Campanella).

B. From hydra-like young arising from eggs (Aurelia and Cyanea) and presenting the following phases of growth:—

1. Egg.
2. Morula (?)
3. Planula (Gastrula).
4. Scyphistoma.
5. Strobila.
6. Ephyra.
7. Aurelia (adult).

LITERATURE.

Nearly the same as for the Hydroids.

REVIEWS AND BOOK NOTICES.

HAYDEN'S GEOLOGY OF COLORADO.[1]—Within this bulky volume of over seven hundred pages is contained a mass of geological, topographical and biological facts concerning Colorado, which it must be confessed reflect great credit on the management of the survey and the industry of the gentlemen employed upon it. Large appropriations have been made by the government for the survey, as accurate and timely information was wanted. We do not see but that ample and speedy returns have been made. The best possible topographical work was wanted, and the public have it from the best possible source. Information concerning the mines of Colorado is here given, while the bulk of the volume is taken up with the legitimate kind of work to be expected from such a survey. To this are to be added reports on the fossil animals and plants, and the living animals and plants of Colorado, thus making it a handbook for the general reader and traveller as well as scientist.

The geological and palæontological work (fossil plants as well as animals) and the living animals, are more fully illustrated than in former reports. The outline illustrations, showing the topography in combination with the geology, are admirable. We have

[1] Annual Report of the United States Geological and Geographical Survey of the Territories, embracing Colorado, being a report of progress of the exploration for the year 1873. By F. V. Hayden, U. S. Geologist, Washington, D.C. 1874. 8vo. pp. 718. With maps and illustrations.

obtained clearer ideas than ever before of the scenic features of the Rocky Mountains.

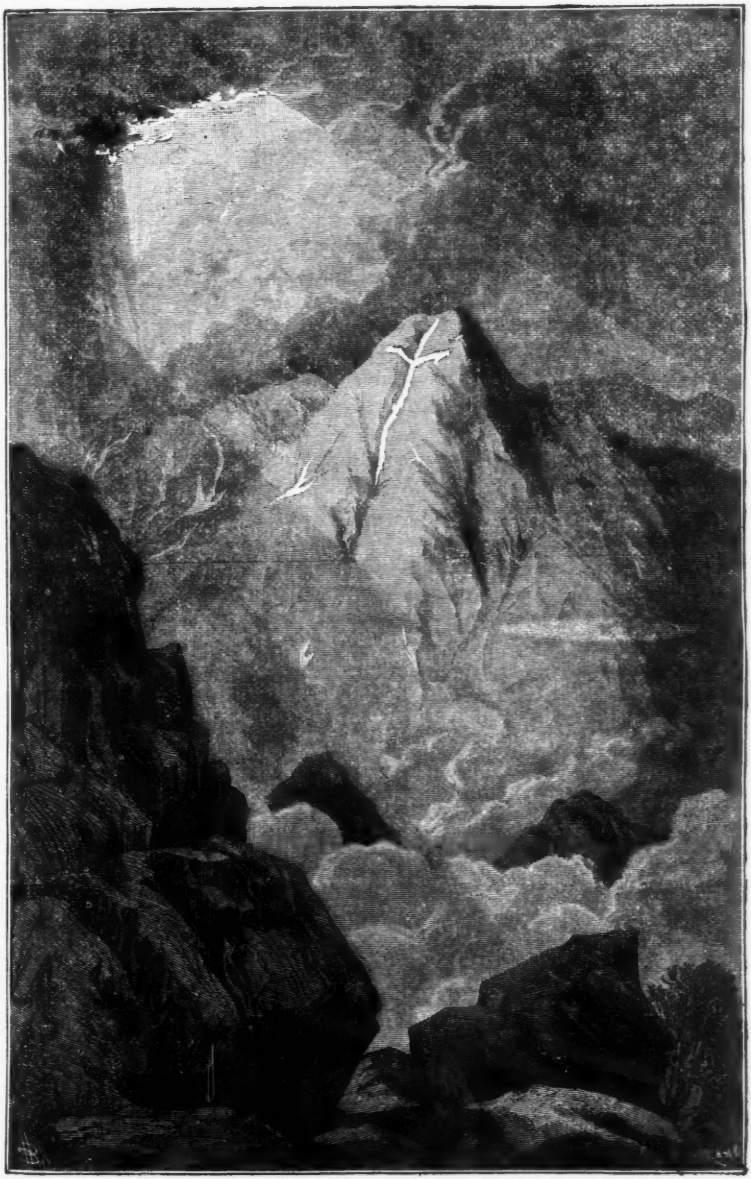
The elevated plateau and mountains of Colorado have a unique interest to the naturalist. Most interesting questions in the distribution of life, both horizontal and vertical; the relation of the physical aspects of Colorado as compared with the plateaux of Asia and the mountains arising from them, will find a partial solution in the data given in this report.

In the first eighty pages Dr. Hayden describes the chief objects of geological interest from Denver to the south and middle parks. Some interesting facts are given concerning the ancient glaciers of Colorado. He says that there is evidence that the Arkansas valley was formerly filled with an enormous glacier with branches of greater or less magnitude, leaving lake basins, moraines and immense granite bowlders scattered over the surfaces. The figure[2] on page 177 is a view of the rounded and polished rocks in the valley of a stream which rises among a group of peaks of which the Mountain of the Holy Cross (Fig. 68) is the most conspicuous. "The mountains on either side rise to the height of 2,000 to 3,000 feet above the valley, and the glacial markings are visible 1,200 to 1,500 feet. The morainal deposits on the northwest side reach a height of 1,200 feet above the stream, and form a sort of irregular terrace, which, when cut through by the little side-streams, show that it is made up of gravel and bowlders much worn. In some instances there are well-worn cavities in the sides of the mountains, showing how the running water, in connection with a mass of rock, formed the cavity much as a 'pot hole' is made in our streams at the present time. Many of the 'sheep backs' are still covered with a crust-like enamel, but usually this has peeled off."

Returning to the Mountain of the Holy Cross, we are told that the main mass of the peak, like the whole of the Sawatch range, is composed of granite gneiss. The summit of the Holy Cross is covered with fragments of banded gneiss. The amphitheatres on all sides have been gradually excavated, as heretofore described, and the more or less vertical sides show the intermediate steps very clearly. The characteristic feature of the Mountain of the Holy Cross is the vertical face, nearly 3,000 feet on the side, with

[2] We are indebted to the courtesy of Dr. Hayden for the use of electrotypes of the accompanying figures.

Fig. 68.

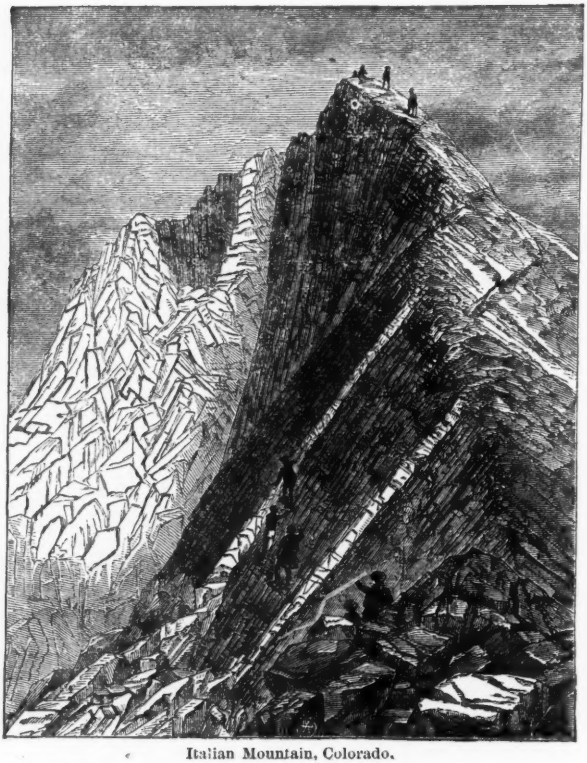


Mountain of the Holy Cross, Colorado.

Fig. 69.

Gothic Mountain, Elk Range, Colorado.

Fig. 70.



Italian Mountain, Colorado.

a cross of snow which may be seen at a distance of fifty to eighty miles from other mountain-peaks. This is formed by a vertical fissure about 1,500 feet high, with a sort of horizontal step, produced by the breaking down of the side of the mountain, on which the snow is lodged and remains more or less all the year. Late in the summer the cross is very much diminished in size by the melting of the snow which has accumulated in the fissures. A beautiful green lake lies at the base of the peak, almost up to

Fig. 71.

Rounded Rocks on Roches Montonnées Creek, Colorado.

timber line, which forms a reservoir for the waters from the melting snows of the high peaks."

The contrast of the volcanic peaks with the granite mountains is seen in the accompanying sketches of Gothic mountain (Fig. 69) and Italian mountains (Fig. 70).

The reports on the geology of special areas are by Messrs. Marvine, Peale and Endlich, and are fully illustrated with maps and sections. The report on fossil plants by Mr. Lesquereux contains valuable remarks on the age of the North American Lignitic formation, the climate of the North American Tertiary Period, ac-

companied by descriptions of a large number of new fossil plants. Prof. Cope's report on the fossil vertebrates of Colorado contains descriptions of several new species with eight lithographic plates illustrating them. The zoology of Colorado is treated of in papers by Lt. Carpenter, Baron Osten Sacken, Dr. Hagen, and Messrs. Ulke, Smith, Verrill, Binney, and Packard. The report on the geography and topography of Colorado, by Mr. James T. Gardiner, possesses a high degree of interest, and is an important contribution to American geography.

BOTANY.

The Lotus in the Detroit River. — Early in the summer of 1868, I attempted the introduction of the Lotus or Chincopin (*Nelumbium luteum* Willd.) into the Detroit River, by planting the seed in nine different places. In company with Mr. Richard Storrs Willis, I planted (May 2, 1868) some of the seed in three places in the Bayou, at his residence at Belle Isle. Mr. Willis subsequently informed me that one plant was the result of my sowing; but I do not know that it ever arrived at perfection. I have not known of my other locations resulting in even this partial success. But last summer, at a field meeting of the Detroit Scientific Association, at Grosse Isle, several of the flowers of this beautiful species were brought me for determination by Miss Douglass, who had discovered and gathered them the day before (August 11, 1874) in the Cannard River, Ontario (a tributary of the Detroit) opposite Grosse Isle. They may have been overlooked there a long time. The year previous a young lad had told of finding, in the Cannard, a water lily different from all others, which led to the above result.

A gentleman has also succeeded in growing the plants from seed in the Rouge River, which falls into the Detroit a few miles below the city. They blossomed for the first time last summer. Another friend, who sowed the seed a year or so ago, has had as yet no appearance of its growth. I am aware that it often takes years to germinate after planting. On August 12, 1872, a seed which I had planted in my aquarium, 4½ years before, rose to the surface of the water in the act of germinating. It afterwards sank to the bottom, and settling in the mud, but not rooting, sent out a long shoot, which (leaf and petiole), on August 17, in 24 hours, grew 4½ inches in length, the weather being very warm.

One could almost *see* the growth. Another seed planted at the same time and in the same place germinated in one year. — HENRY GILLMAN, *Detroit, Mich.*

ZOOLOGY.

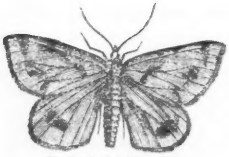
THE GEOMETRID MOTHS. — The undersigned, desirous of perfecting as far as possible a monograph of the Geometrid moths, would beg the assistance of collectors, especially in the western and southern states, during the coming season. He would like information especially regarding the early stages, viz.: specimens and descriptions of the larva, chrysalis and their habits, as well as the food plants of any, even the most common species. Due credit will be given for any new facts. Out of about four hundred species in North America, we know of the caterpillars of but about twenty species. A number of illustrations[1] on the next page show the forms characteristic of this extensive family. The caterpillars are loopers or geometers, and are very familiar objects, feeding usually on low bushes and herbaceous plants late in summer.

As every species known is to be figured, it is hoped that entomologists will lend their rarities, and thus aid in the publication of what, it is hoped, will be a useful contribution to the study of our moths. To those aiding by the loan of over twenty specimens, a copy of the work will be sent. The larvæ can be reared easily; full instructions may be found in the "Directions for preserving and collecting Insects," recently published by the Smithsonian Institution, and which can be had on application to the subscriber.

Any moths of this family sent to the subscriber will be named and carefully returned if desired. The work is about ready for the press, and specimens are desired at once. The collecting season is May, June and July, in the middle and northern states, June being the month when they are most abundant. — A. S. PACKARD, Jr.

A DOUBLE HEADED LARVA OF A FLY. — Professor Weyenbergh of Cordova, La Plata, describes a double headed larva of Chironomus. The body seems double throughout, though the two heads begin to unite on the second segment behind the head, and become fully united on the sixth.

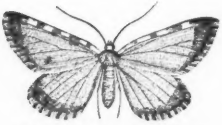
[1] Most of the cuts are kindly loaned by Prof. F. V. Hayden, having been taken from his annual report for 1873 on the Geology of Colorado Territory.



Eufitchia ribearia.

Euaspilates spinataria.

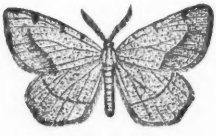
Macaria Californiata.



Marmopteryx tessellata.

Aspilates 4-fasciaria.

Drepanodes varus, with larva and pupa.



Caulostoma occiduaria.

Anisopteryx vernata.

EXAMPLES OF GEOMETRID MOTHS.

INFLUENCE OF ELEVATION AND LATITUDE UPON THE DISTRIBUTION OF SPECIES.—It is surprising to what extent observers still overlook the fact of the influence of elevation upon the distribution of animal and vegetable life;—that they should still regard parallels of latitude, instead of isothermal lines, as bounding the habitats of species. That such is the case, however, is sufficiently apparent from such notices as that in the December NATURALIST, respecting the summer distribution of the chestnut-sided warbler (*Dendroica Pensylvanica*), which is but a sample of such remarks as frequently occur in reference to the distribution of our birds and mammals. The merest tyro in the study of the geographical distribution of animals knows that their range is not only determined by climatic influences, but that these influences depend largely upon the character of the surface of the country, as, for instance, whether it is a level plain or is broken by mountain ranges, and that increase in elevation is climatically equivalent to an increase in latitude. If authors would use isothermal lines in giving the distribution of a species, instead of arbitrary political divisions, they would be able to speak with much greater precision in such matters than is customary at present. The isotherms are now so well established, and a knowledge of them may be so easily acquired by means of our meteorological maps, that it seems quite time to adopt them in speaking of the distribution of species.

While southern New England may, generally speaking, form the southern limit of the breeding range of a bird, or of the distribution of a mammal, reptile or plant, the same species may, and generally does, exist in the highlands of the Alleghanies as far south as northern Georgia; and even species which occur only to the northward of southern Maine, in the lowlands, not only occur in the highlands of Berkshire county, Massachusetts, but also southward in the Alleghanies to North Carolina.

A great point will be gained in precision when naturalists come to use natural faunal areas, instead of arbitrary political divisions, in speaking of the distribution of species. If Dr. Brewer had said, in speaking of the chestnut-sided warbler, "*not known to breed south of the Alleghanian Fauna*," instead of "not known to breed farther south than Massachusetts," he would not only have expressed the fact with precision, so far as our present knowledge extends, but would have saved himself the exposure to such criticism as that made by Mr. Stark (Am. Nat., VIII, p. 756, Dec.,

1874). I mention the present case merely by way of illustration, and not for the purpose of making any special strictures upon my friend Dr. Brewer, who is by no means in this respect an exceptional transgressor. If it is urged that the people would not understand such expressions as the "Alleghanian Fauna," and the like, it may be said that the time has come when they should be familiar with them. Most intelligent people know that isothermal lines vary in direction with the elevation and contour of the land over which they pass, sweeping, in our own country, far to the southward in leaving the lowlands of the Atlantic coast; that they pass southward of the Appalachian Highlands, and then bend abruptly northward again along their western base. It is time they knew, also, that the different zones of animal life follow the flexures of the isotherms, and that there are natural faunal belts, sufficiently distinct to be capable of recognition, whose boundaries coincide very nearly with certain of these isotherms. Furthermore, that throughout eastern North America, at least, these faunal belts are already well known to specialists of the subject, and that there already exist definite expressions for such cases as the one that has furnished the text for the present note. I will add, also, that so much is already known of the laws of the geographical distribution of animal life, that one could have safely assumed, from our present knowledge of the general range of the chestnut-sided warbler, that from its being a rather common summer resident in southern New England, it would also be found to breed in the mountainous districts as far south even as northern Georgia.—J. A. Allen.

GEOLOGY AND PALEONTOLOGY.

New Order of Eocene Mammals.—At the last meeting of the Connecticut Academy, Feb. 17th, Professor O. C. Marsh made a communication on a new order of Eocene Mammals, for which he proposed the name *Tillodontia*. These animals are among the most remarkable yet discovered in American strata, and seem to combine characters of several distinct groups, viz.: Carnivores, Ungulates and Rodents. In *Tillotherium* Marsh, the type of the order, the skull has the same general form as in the bears, but in its structure resembles that of Ungulates. The molar teeth are of the ungulate type, the canines are small, and in each jaw there is a pair of large scalpriform incisors faced with enamel, and grow-

ing from persistent pulps, as in Rodents. The adult dentition is as follows : — Incisors $\frac{2}{2}$; canines $\frac{1}{1}$; premolars $\frac{3}{2}$; molars $\frac{3}{3}$. The articulation of the lower jaw with the skull corresponds to that in Ungulates. The posterior nares open behind the last upper molars. The brain was small, and somewhat convoluted. The skeleton most resembles that of Carnivores, especially the *Ursidæ*, but the scaphoid and lunar bones are not united, and there is a third trochanter on the femur. The radius and ulna, and the tibia and fibula are distinct. The feet are plantigrade, and each had five digits, all terminated with long, compressed and pointed, ungual phalanges, somewhat similar to those in the bears. The other genera of this order are less known, but all apparently had the same general characters. There are two distinct families, *Tillotheridæ*, in which the large incisors grew from persistent pulps, while the molars have roots ; and the *Stylinodontidæ*, in which all the teeth are rootless. Some of the animals of this group were as large as a tapir. With *Hyrax* or the *Toxodontia* the present order appears to have no near affinities.

ANTHROPOLOGY.

Clay-balls as Slung Shot or Cooking Stones. — Round balls of clay as hard as that material could be made were seen in the museum of Nassau, N. P., labelled from a cave in the Islands. These might be used for two purposes, as they were round and the size of a hen's egg ; first, their size and shape fitted them for a weapon of warfare, if wrapped in buckskin or hide drawn very tight over it and fastened, leaving a loose end, which, being firmly fastened over a strong stick, forms a formidable slung shot. The Apache Indians make and use the same kind of implement, which they use in battle, only their balls are of stone. The second use to which they might be applied is in cooking. After being heated very hot they were probably placed in the substance to be cooked, then taken out and this operation repeated until required no more. The ancient Indians of the Bahamas made pottery, as pieces found testify, therefore they could cook in vessels of pottery when stationary, but if travelling, it would be inconvenient to carry them, as they easily break ; but they could make deep baskets, or trays of twigs, or leaves of the palm-trees so tight that they held water ; thus, by putting water with whatever

was desired to cook, they would drop in these balls of clay red hot, and repeat the operation until the cooking was completed, without injury to the basket. There are several tribes of Indians in Arizona, New Mexico, Utah and California, which make water-tight baskets of willow twigs, and I have several times seen them cook by heating stones and dropping them into these baskets filled with the articles to be cooked. It might be urged against this mode of cooking, that it wasted the food, as so much must stick to the balls every time they were taken out. This would be true if they did not use their tongues to clean off all that adhered. Then if the mass were increased by a few ashes adhering to the balls, that would be nothing to them. Ashes were at least as healthy for them, as pepper and other condiments used by white men. — E. PALMER.

MICROSCOPY.

AMERICAN MICROSCOPICAL SOCIETIES.—The following list of Microscopical organizations is published to facilitate the work and increase the intercourse of the societies themselves, as well as of microscopists generally. Revised lists will be published from time to time, for which purpose secretaries and others interested are specially requested to furnish such corrections and additions as may become necessary.

AGASSIZ INSTITUTE, Sacramento, Cal. Organized 1874. *Secretary*, Rev. J. H. C. Bronte.

ACADEMY OF NATURAL SCIENCES, Philadelphia, Pennsylvania; Biological and Microscopical Section. Meets first Monday evening of month. *Director*, W. R. S. Ruschenburger, M. D.; *Vice-Director*, James Tyson, M. D.; *Recorder*, J. G. Richardson, M. D.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE; Microscopical Sub-Section. Meets occasionally in connection with the migratory sessions of the Association.

AMERICAN MICROSCOPICAL SOCIETY OF NEW YORK. Organized 1865. Meets second and fourth Tuesday evenings of the month. *President*, John B. Rich, M. D.; *Vice-President*, W. H. Atkinson, M. D.; *Secretary*, C. F. Cox, Port Richmond, Staten Island, N. Y.; *Treasurer*, Prof. T. L. Orenieu; *Curator*, Wm. Dean.

BAILEY CLUB, New York City. A small club of working members. Meetings informal, every second Tuesday.

BOSTON MICROSCOPICAL SOCIETY. Organized 1873. Meets first and third Thursdays of month, at residences of members. *President*, L. M. Willis, M. D.; *Vice-President*, I. J. Wetherbee, D. D. S.; *Secretary* and *Treasurer*, R. R. Andrews, M. D., Brattle Square, Cambridge, Mass.

BOSTON SOCIETY OF NATURAL HISTORY; Microscopical Section. *Committee*, E. Bicknell, R. C. Greenleaf, B. Joy Jeffries, M. D.

DARTMOUTH MICROSCOPICAL CLUB, Hanover, N. H. *President*, Prof. E. Phelps; *Vice-President*, Prof. L. B. Hall; *Cor. Secretary*, H. A. Cutting, Lunenburgh, Vt.

FAIRMOUNT MICROSCOPICAL SOCIETY of Philadelphia. Organized 1871. Meets monthly. *President*, F. F. Milne; *Secretary* and *Treasurer*, Wm. C. Stevenson, Jr., 24 South 4th St.

INDIANA MICROSCOPICAL SOCIETY, Indianapolis, Ind. Organized 1874. Meets first Friday evening of month. *President*, William B. Fletcher, M. D.; *Secretary* and *Treasurer*, E. Hadley, M. D., 191 Va. Ave.

KIRTLAND SOCIETY OF NATURAL HISTORY, Cleveland, Ohio; Microscopical Branch. *Secretary*, John Bowers.

LOUISVILLE MICROSCOPICAL SOCIETY, Louisville, Ky. Organized 1874. *President*, Prof. J. Lawrence Smith; *Vice-Presidents*, Noble Butler and C. F. Carpenter, M. D.; *Treasurer*, C. J. F. Allen; *Secretary*, John Williamson; *Cor. Secretary*, E. S. Crosier, M. D.

MARYLAND ACADEMY OF SCIENCES, Baltimore, Md.; Section of Biology and Microscopy. Meets first and third Wednesday evenings of month. *Chairman*, Christopher Johnston, M. D.; *Secretary*, W. G. Harrison, M. D., 69 Centre St.

MEMPHIS MICROSCOPICAL SOCIETY, Memphis, Tenn. Organized 1874. Meets first and third Thursday evenings of month. *President*, S. P. Cutler, M. D.; *Secretary* and *Treasurer*, A. F. Dod, 257 Main St.

NEW JERSEY MICROSCOPICAL SOCIETY of the City of New Brunswick, N. J. Meets second Monday evening of month at Rutger's College. *President*, Prof. F. C. Van Dyck; *Rec. Secretary*, Rev. Sam'l Lockwood, Ph.D., Freehold, Monmouth Co., N. J.

PROVIDENCE FRANKLIN SOCIETY, Providence, R. I.; Microscopical Department. Organized 1874. *Chairman*, Prof. Eli W. Blake; *Secretary*, Prof. John Peirce, Post office box N. N.

SAN FRANCISCO MICROSCOPICAL SOCIETY, San Francisco, Cal. Organized 1872. Meets first and third Thursdays of month. *President*, Henry G. Hanks; *Vice-President*, Arthur B. Stout, M. D.; *Rec. Secretary*, C. Mason Kinne, 422 Cal. St.; *Cor. Secretary*, Henry C. Hyde; *Treasurer*, Chas. G. Ewing.

SOCIETY OF NATURAL SCIENCES, Buffalo, N. Y.; Microscopical Section. Organized 1872. *Curator*, Henry Mills, 162 Fargo Ave.

STATE MICROSCOPICAL SOCIETY OF ILLINOIS, Chicago, Ill. Organized 1869. Meets second and fourth Fridays of month. *President*, S. A. Briggs; *Cor. Secretary*, O. S. Westcott.

STATE MICROSCOPICAL SOCIETY OF MICHIGAN, Kalamazoo, Mich. *President*, Rev. Dr. Foster.

TROY SCIENTIFIC ASSOCIATION, Troy, N. Y.; Microscopical Section. Organized 1870. Meets monthly. *President*, R. H. Ward, M. D.; *Vice President*, Rev. A. B. Hervey; *Secretary*, Prof. Arthur W. Bower, 35 Seventh St.

TYNDAL ASSOCIATION, Columbus, Ohio; Microscopical Section. Organized 1874. *President*, Prof. Albert H. Tuttle; *Secretary*, C. Leo Mees; *Curator*, Rev. I. F. Stidham, 171 South 3d St.

NEW SLIT FOR TESTING ANGULAR APERTURE.—Believing Mr. Wenham's apparatus for this purpose to be unnecessarily complicated, Mr. Tolles has constructed a very simple substitute which is easily made and used. A piece of silvered glass mirror is cut to a convenient size (say 3x1), the silvered surface being protected by varnish so that it can be handled. Through the silvering a vertical slit is cut, the surface of the slit being cleaned by a little dilute acid. This slit may be as wide as the field of the highest power objective to be tested. A part of this slit is covered with a cover-glass under which and directly upon the slit are test diatoms, dry upon one portion of the covered part of the slit and balsam-mounted upon the rest, so that the slit can be used while tests of the definition of the objective are actually in view. If a high-angle objective be adjusted for the thickest cover it is capable of working through, and then tested upon the uncovered portion of this slit, the very great aberration will give a small and imperfectly defined angle; if then tested upon the covered portion of the slit, the definition is greatly improved and the angle largely increased. If now water or glycerine is introduced to make contact between the cover and the objective, definition becomes good, and the diatoms are exhibited on a well illuminated field, while the aperture, now an immersion angle, can be measured with the

proper appliances, such, for instance, as the semi-cylinder originally introduced for this purpose by Mr. Tolles.

A slit one-half or one-third as wide as the field gives equally good results where water-contact of the objective is used, but when working through air reduces the angle to an evidently fallacious degree. Glycerine is a better substitute for glass than water is, and therefore for a thin cover and an objective corrected for best work through thick covers, glycerine should always be preferred to water as the immersion-fluid.

"180°" Angular Aperture. — The latest contribution to this subject is a note from Mr. Wenham, which, besides its personalities, consists of a violent attack upon an article in the Naturalist for advocating "180°." As the article referred to simply mentioned the 180° as the claim of a certain optician, and did not say one word in favor of the propriety of the claim, the minor inaccuracies of Mr. Wenham's note may well pass uncorrected, while its sneering tone will be rated at its true worth by those who are familiar with the courtesies of literature and science. The treatment which Mr. Wenham has received from the Naturalist for years past is sufficiently well known.

Lest any future writer, rather than use a tiresome circumlocution, should unfortunately say 180° when he wished to say indefinitely near to 180°, it would be well to have it understood that no one need consider it either necessary or handsome to make such unguarded expression the occasion of an abusive reply.

Caps for Mounting Opaque Objects. — Prof. John Peirce of Providence, R. I., has had a die cut for making a novel kind of cell, which is excellent for mounting large opaque objects, such as many mineral specimens and nearly all seeds, which require to be permanently preserved and at the same time show best without a cover-glass. The cell is made of thin copper, and has the shape of a hat with a very low crown. The rim at the bottom is to be cemented with marine glue to the glass slide, and the top of the crown is a removable cap slipped on or off at pleasure, so that the object can be examined or manipulated with the greatest facility. Though not prepared for the trade, they could probably be obtained, in exchange or otherwise, by any microscopist.

Rogers' Micrometers and Test Plates. — Mr. Rogers of the Cambridge Observatory has made arrangements to furnish micros-

copists with samples of his fine ruling on glass which has been already noticed in the NATURALIST. The lines, which excel any with which we are familiar except the Nobert lines, are now ruled from $\frac{1}{100}$ to $\frac{1}{18000}$ inch, on glass slips 3 x 1, and covered with thin glass. They cost $8 or less, according to fineness.

THE ARGAND BURNER. — Microscopists who use illuminating gas with the common Argand burner will be interested in Mr. John H. Martin's suggestion of placing a thin piece of mica, with a small hole punched in its centre, upon the top of the glass chimney. A more perfect combustion of the carburetted hydrogen is secured, giving a very steady flame, and the full amount of light with the gas turned about half off.

MONOCHROMATIC SUNLIGHT. — Instead of a small disk of blue glass which has long been used in connection with a shutter or diaphragm or with some illuminating apparatus, Mr. J. E. Smith recommends a blue glass pane of about 12 x 18 inches, standing at the edge of the table, between the microscope and an open window through which the direct sunlight enters. The pane is supported by a cleat, so that it can be instantly placed in position or removed. The whole instrument stands in the blue light, and is managed exactly as with ordinary diffused daylight.

AMPHIPLEURA PELLUCIDA. — The latest measurement of the striæ of this favorite "test" is that of Prof. E. W. Morley, of Hudson, Ohio, communicated to the Memphis Microscopical Society, which estimates the markings at 92,600 to the linear inch.

NOTES.

PROFESSOR LUDWIG'S *Jubiläum* or the celebration of the twenty-fifth year of his professorship, took place at Leipzig, October 15. This eminent teacher, founder of the Saxon Physiologische Anstalt has in the past quarter of a century had more than a hundred and fifty private students, whom he has trained in special investigations, and of whom many have since become distinguished professors. There was a large assemblage of friends and pupils to take part in the ceremonies, including Professors Ernst Heinrich Weber, the Nestor of physiology; Helmholtz, Du Bois Reymond, and others of less fame from Upsala, Moscow, Edinburgh, Brussels, Vienna, etc. The oldest scholar proved to be Professor Fick,

of Zürich, and on him devolved the congratulatory address, at the conclusion of which a curtain fell, uncovering a bust of Professor Ludwig which had been made by Professor Schilling of Dresden. Professor Cyon, of St. Petersburg, spoke in behalf of Ludwig's Russian students, and the curtain fell again, displaying an exquisite silver clock. Professor Müller presented an album with photographs of all his pupils. But the finest of possible gifts was the superb volume of sixteen memoirs on anatomy and physiology which had been prepared as a lasting commemoration of the day. Then followed addresses from former colleagues in Zürich and Vienna, and presentations of memoirs dedicated to Ludwig and sent by various learned societies. In the afternoon the company assembled again in the Hôtel Hauffe for a dinner given to the Professor, at which there was more speech-making. "I am an old man," said Weber in private conversation, "but I have never seen or heard of so much honor being done to any professor. It has never happened (*Es ist nie dagewesen*)." In the evening, at Professor Ludwig's own house, the guests found fifty congratulatory telegrams spread upon the table, which had been sent from the principal towns of every part of Europe.—*Nation.*

The trustees of the Peabody Museum of Yale College,—Professors James D. Dana, Benjamin Silliman, George J. Brush and Othniel C. Marsh, Gov. Ingersoll, Hon. R. C. Winthrop, and G. P. Wetmore,—have decided to proceed to the immediate erection of one wing of the building, at a cost of $160,000. The lot on which it is to stand extends from Elm to Library streets, being one hundred and forty-five feet deep, and four hundred and fourteen feet in length. The front of the entire building will extend three hundred and fifty feet on High street. The wing to be erected at this time will have a front of one hundred fifteen feet on High, and one hundred feet on Elm streets, and will contain three stories with a high basement. The basement will contain working rooms, and fossil foot-prints; the first main story, a lecture room and mineralogical specimens; the second story, geology, especially fossil vertebrates; the third story, zoological specimens; the attic, archæological and ethnological specimens. The mineralogical collection of the Museum is to be under the charge of Professor G. J. Brush, the geological department under Professor O. C. Marsh, and the zoological under Professor A. E. Ver-

rill. The original gift of Mr. Peabody was $150,000, with the provision that a fire-proof building be erected, and $50,000 kept as a reserve fund. In accordance with the terms of the gift, the land is to be given by the college, and the building, when completed, is to be the property of the college. A building fund has been reserved which will not be used until it amounts to at least $100,000.

Sir Charles Lyell, the eminent geologist, died Feb. 22, at the age of seventy-seven. He was born Nov. 14, 1797. He began to publish geological papers in 1826. In 1830 appeared his "Principles of Geology." This work was original in its method, as the author sought to explain past geological events by laws in operation at the present time. The doctrine is called Uniformitarianism, and is of a piece with Darwinism and evolution. Lyell in a measure was to geology what Darwin is to biology.

Sir Charles Lyell visited this country in 1841. His journey resulted in the publication of "Travels in North America in 1841–2." "A Second Visit to the United States" appeared in 1849. His "Geological Evidences of the Antiquity of Man" was published in 1863, in which he endorsed the theory of Mr. Darwin, though previously opposed to the development hypothesis, which his whole course of geological thought had unconsciously perhaps to himself favored.

The Cornell University has just received from Australia, through Prof. H. A. Ward, a fœtal Dugong (*Halicore australis*), about 2½ feet long, well preserved in salt. The intestines had been removed, but the other viscera, including the peculiar bifid heart, are in good condition.

It is my hope that its dissection may throw some light upon the general homology of the pectoral muscles with mammals; and that its brain and other organs may lend some aid to our knowledge of the relations of this peculiar group of aquatic Herbivora. — Burt G. Wilder.

The Newark (New Jersey) Scientific Association was organized in January last, with the following officers:—President, Dr. A. M. Edwards; Vice President, Dr. A. N. Dougherty; Secretary, G. J. Hagar; Treasurer, W. S. Nichols. The Association will hold monthly meetings, give lectures and form a cabinet. It intends to pay special attention to local natural history, and do what it

can in promoting science in Newark and vicinity. We are glad to see these new societies come into existence, and hope that every city and town in the country will soon have its scientific society.

We have been requested by the author to state that the Congressional edition of Capt. W. A. Jones' report on his reconnaissance of N. W. Wyoming, in 1873, contains only one-half of Mr. T. B. Comstock's geological report. The copies ordered for the use of the Engineer Office in Washington (to be published as soon as possible) will contain seven more chapters, with twenty-nine additional cuts. The forthcoming portion will be more valuable than the eight chapters already published.

"The Natural History Association of North Western College," at Naperville, Illinois, has recently completed its organization. The following are the officers:—J. L. Rocky, President, A. Goldspohn, Vice President, J. W. Troeger, Secretary, C. F. Rassweiler, A. M., Treasurer, Prof. H. H. Rassweiler, Curator, Miss N. Cunningham, Directress of the Botanical Department, C. H. Dreisbach, Director of the Mineralogical, and J. W. Troeger of the Zoological.

The "Dunkirk Microscopical Society" was organized in June last and now consists of thirteen members. Its officers are Prof. J. W. Armstrong, D. D., President, and Geo. E. Blackham, M.D., Vice President, Treasurer and Secretary. Its regular meetings are held on the second Friday of each month.

A Fungus show has been held at Munich, in the Crystal Palace there, from October 3rd to 11th, and is said to have been visited by nearly 50,000 persons. The arrangements were well made and the plants carefully labelled. A list of the species exhibited will be found in the "Gardener's Chronicle."

The Memphis Microscopical Society, organized last summer, with a membership at the outset of about thirty, is doing good work. At least one paper of considerable importance has been read at its monthly meetings. Papers or specimens are earnestly desired, in order to add to the interest of the meetings.

A society for the promotion of science and history was formed in November last under the title of the Central Ohio Scientific Association, at Urbana, Ohio. Theo. N. Glover is the president and Thos. F. Moses the corresponding secretary.

Dr. Gideon Lincecum, of Long Point, Texas, died November 28, 1874, of paralysis. He was a valued contributor to this journal, and his papers showed keen powers of observation. His most remarkable contributions were on the agricultural ants of Texas.

Charles Kingsley, reformer, novelist, poet and naturalist, died Jan. 25, aged fifty-five. His "Glaucus, or Wonders of the Shore," is one of the most inspiring popular science books ever written, and evinced the hearty love of science of its gifted author.

The plants collected in Florida by Dr. E. Palmer, have been named by Prof. Gray and Mr. Watson. They are made into sets and are for sale. Apply to Prof. Asa Gray, Botanical Garden, Cambridge, Mass.

A German society in Japan has issued its first volume of Proceedings, containing a notice of a cuttle fish (*Ommastrephes*) fourteen feet in length, captured on the coast of Japan.— *Monthly Microscopical Journal.*

Dr. R. E. Grant, the anatomist, best known for his studies on the sponges, died in London, August 23.

EXCHANGES.

The Memphis Microscopical Society is prepared to offer exchanges of unmounted microscopic objects. Lists furnished by A. F. Dod, Sec'y, 257 Main St., Memphis, Tenn.

BOOKS RECEIVED.

The Common Frog. By St. George Mivart. Macmillan & Co. London, 1874. Nature Series. Illustrated. pp. 158. 8vo. Price $1.00.

Archiv fur Anthropologie. Zeitschrift fur Naturgeschichte und Urgeschichte des Menschen. Braunschweig, 1874.

Notice sur l'Empire du Japon. Yokohama, 1873. pp. 85. 8vo.

Special-Catalog der chinesischen Ausstellung. III Abtheilung. Wien, 1873. pp. 49. 8vo.

Das Winkler'sche Taschen-Dendrometer. By Franz Grossbauer. Wien, 1874. pp. 144. 8vo.

La Retraite de Laguna. By Alfred D'Escragnolle Taunay. Rio Janeiro, 1871. pp. 224. 8vo.

Die Œsterreichischen Alpenländer und ihre Forste. By Joseph Wessely. Wien, 1853. pp. 809. 8vo.

Die Lehre vom Dunger. By Emil Kirchof. Wien, 1872. pp. 336. 8vo.

Die Forstwirthschaftslehre fur Forstmanner und Waldbesiker. By Leopold Grabner. Wien, 1856. pp. 290. 8vo.

Das Rechnungswesen fur forster oder forstverwaltungen. By Agnaz Maur. Wien, 1859. Dritte vermehrte Auflage. pp. 345. 8vo.

Die Lehrforste der Eisenacher Forstschule: Eisenach, Wilhelmsthal, Ruhla. By Carl Grebe. Gisenach, 1858. pp. 74. 8vo.

Compendium der Jagdunde. By Christof Liebich. Wien, 1855. Illustrated. pp. 360. 8vo.

Notions on the Chorography of Brazil. By Joaquim Manoel de Macedo. Translated by H. Le Sage. Leipzig, 1873. pp. 576. 8vo.

Der Buchen-Hochwaldbetrieb. By Carl Grebe. Gisenach, 1856. pp. 236. 8vo.

Die Beaufsichtigung der Privatwaldungen von Seiten des Staates. By C. F. A. Grebe. Gisenach, 1845. pp. 139. 8vo.

Die Industrie des Konigreichs Wurttemberg. Prag, 1873. pp. 111. 8vo.

Schweizerischer Katalog. Wien, 1873. With charts. pp. 295. 8vo.

Verzeichniss der Producte, welche die landwirthschaftliche Gesellschaft von Santiago de Chili zur Wiener Weltausstellung abgesandt hat. Wien, 1873 pp. 11. 8vo.

Leitfaden fur den Unterricht und die Prufung. Wien, 1861. With cuts pp. 326. 8vo.

Conference Sanitaire Internationale a Vienne, 1874. With chart. pp. 361. 4to.

Schematismus und Statistik du Staatsforste. By Karl Schindler. Wien, 1864. pp. 214. 8vo.
Einrichtung des Forstdienstes in Oesterreich. By J. Wessely. Wien, 1866. pp. 807. 8vo.
Rationelle Zucht der Sussrasserfische. By Raphael Molin. Wien, 1864. pp. 346. 8vo.
Forstbenakung. By G. Konig. Eisenach, 1861. pp. 435. 8vo.
Holzexport Oesterreichs. By A. F. v. Hohenbruck. Wien, 1869. pp. 303. 8vo.
Lehrbuch der forstlichen Zoologie. By F. M. Eduard Opel. Wien, 1869. pp. 483. 8vo.
Annales de la Societe Entomologique de Belgique. Bruxelles, 1873. pp. 431. 8vo.
Proceedings of the Zoological Society of London, 1874. Part II. pp. 153-248. Part III. pp. 249-488. 8vo.
Diptera, or two-winged Flies. Manuscript Notes from my Journal, or Illustrations of Insects, Native and Foreign. By Townend Glover. Washington, D. C., 1874. pp. 120. 4to.
Babbitt Portfolio. New England Society of Orange, New Jersey. October, 1874. 4to.
Polarization of Light. Nature Series. By William Spottiswoode. London, 1874. pp. 126. 8vo. $1.00.
Chemical and Geological Essays. By T. Sterry Hunt. Boston, 1875. p. 489. 8vo. J. R. Osgood & Co $3.00.
Tables for the Determination of Minerals. By Persifer Frazer, Jr. Philadelphia, 1875. pp. 117. 8vo.
Researches in Acoustics. From the American Journal of Science and Arts, vol. viii, 1874. By Alfred M. Mayer. Paper No 5. pp. 42.
Discrepancies between Theory and Observations of the Moon's Motions. Trans. Kansas Acad. of Selences, 1874. By F. W. Bardwell. p. 4. 8vo.
Index to vol. i to xlii Observations on the Genus Unio. By Isaac Lea. Philadelphia, 1874. vol. iii. pp. 29. 4to.
Report of the Commissioner for 1872 and 1873. U. S. Commission of Fish and Fisheries. Washington, 1874. Part II. pp. 98. 8vo.
Report of the Geological Survey of the State of Missouri, including Field Work of 1873-1874. With atlas. By Garland C. Brodhead. Jefferson City, 1874. pp. 783. 8vo.
Report upon Vertebrate Fossils discovered in New Mexico, with descriptions of New Species. Engineer Department, U. S. Army. By Prof. E. D. Cope. Washington, 1874. pp. 18. 8vo.
Bericht uber die Thatigkeit der St. Gallischen, 1872-73. St. Gallen, 1874. pp. 522. 8vo.
Bulletin Mensuel de la Societe d'Acclimatation. Paris, 1874. 3me Serie, Tome I. Nos. 7, 8. pp. 433-544. 8vo.
Sitzungsberichte der philosophisch-philologischen und historischen Classe der k. b. Academie der Wissenschaften. Munchen, 1873. Heft v, vi. pp. 589-912. 1874. Heft i-iii. pp. 132-372. 8vo.
Sitzungsberichte der Mathematisch-physikalischen Classe der k. b. Akademie der Wissenschaften. Munchen. 1873. Heft iii. pp. 274-344. 1874. Heft i-ii. pp. 240. 8vo.
Uber Deutschlands Weltstellung. Franz Von Loher. Munchen, 1874. pp. 48. 8vo.
Dr. Justus Freiherrn von Liebig zum Gedachtniss. Max von Pettenkofer. Munchen, 1874. pp. 59. 4to.
Gedachtnis-Rede auf Konig Johann von Sachsen. J. von Dollinger. Munchen, 1874. pp. 16. 4to.
Ueber den Einfluss des Freiherrn Justus von Liebig auf die Entwicklung der Physiologie. Theodore L. W. von Bischoff. Munchen, 1874. Eine Denkschrift. pp. 103. 4to.
Justus Freiherr von Liebig als Begrunder der Agrikultur-Chemie. August Vogel. Munchen, 1874. Eine Denkschrift. pp. 61. 4to.
The Species of the Lepidopterous Genus Pamphila. By Samuel H. Scudder. Memoirs Bost. Soc. Nat. Hist., vol. ii. part iii, No 4. Boston, 1874. pp. 341-353. 4to.
Annual Report upon the Geographical Explorations and Surveys West of the One Hundredth Meridian. By George M. Wheeler. Washington, 1874. pp. 130. 8vo.
Elementary Collection of Minerals and Rocks. By E. Seymour. New York, 1874. pp. 37. 8vo.
Natural History, No. 1. On the Muridæ. U. S Northern Boundary Commission. By Elliot Coues. Philadelphia, 1874. pp. 28. 8vo.
New Species of North American Noctuidæ. By Aug. R. Grote. Philadelphia. pp. 17. 8vo. Received Nov. 19, 1874.
Chemical and Geological Essays. By T. Sterry Hunt. Boston, 1875. p. 501. 8vo. cloth. Price $3.00.
Un mot sur le mode d' adherence des males de Dytiscides aux femelles pendant l'acte de l'accouplement. Par Felix Plateau. Gand, 1872. pp. 8. 8vo.
Un parasite de Cheiropteres de Belgique. Par Felix Plateau. Extrait des Bulletins de l'Academie Royale de Belgique. Bruxelles, 1873. pp. 3. 8vo.
Studies on the Facial Region. By Harrison Allen. Philadelphia, 1875. Reprinted from the "Dental Cosmos." pp. 117. 8vo.
Note sur un procede pour donner ou pour rendre leur couleur rouge aux muscles conserves dans l'alcohol. Par Felix Plateau. Bruxelles, 1874. pp. 7. 8vo.
Constitution, By-laws, etc., of the Troy Scientific Association. Troy, 1875. pp. 11. 8vo.
Preliminary Report upon Invertebrate Fossils collected by the Expeditions of 1871, 1872 and 1873, with Descriptions of New Species. By C. A. White. Washington, 1874. Geographical and Geological Explorations and Surveys West of the 100th Meridian. pp 27. 8vo.
Notes on the Natural History of Portions of Montana and Dakota. By J. A. Allen. Boston, 1874. pp. 61. 8vo.
Bulletin of the Torrey Botanical Club. New York. Vol. v, Nos. 10 and 12, Vol. vi, No. 1. Index to Vols. i-v. (With photograph of Dr. Torrey.) 8vo.
Principles of Metal Mining. By J. H. Collins. G. P. Putnam's Sons. New York, 1874. Illustrated. pp. 149. 12mo. Price .75.
Magnetism and Electricity. By John Angell. G. P. Putnam's Sons. New York, 1874. Illustrated. pp. 176. 12mo.
On British Wild Flowers considered in Relation to Insects. By Sir John Lubbock. London. McMillan & Co. 1875. Nature Series. Illustrated. pp. 186. 8vo. Price $1.50.
Lists of Elevations principally in that portion of the United States west of the Mississippi River. Washington, 1875. Hayden's Geological Survey of the Territories. Miscellaneous publications. No. 1. pp. 72. 8vo.
Notice of the Chemical and Geological Essays of T. S Hunt. By James D. Dana. From Am. Jour. Sci. and Arts. Vol. ix, Feb., 1875. pp. 102-106. 8vo.
Notice of New Tertiary Mammals, IV. By O. C. Marsh. From the Am. Jour. Science and Arts, March, 1875.) Received February 28, 1875.